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AMERICAN FOUNDRYMEN'S ASSOCIATION.

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PROCEEDINGS OF THE THIRD ANNUAL CONVENTION OF AMERICAN FOUNDRYMEN'S ASSOCIATION.

CINCINNATI, JUNE 7, 8, 9, 10, 1898.

If a greater assemblage and increased interest in the topics discussed at the yearly meeting of the American Foundrymen's Association may be taken as a criterion, the zenith of usefulness has not yet been reached by this body of representative American foundrymen. The meeting which closed in Cincinnati on June 10 was in every way superior to any of its predecessors, in attendance as well as in the activity manifested in the welfare of the Association.

As previously announced, the first day was largely given over to the registration of delegates, although the entertainment committee, headed by D. B. Meacham, began to show its liberality early in the day by giving a trolley ride to the early arrivals to Chester Park. In the evening those who felt no fatigue from their more or less extended journey, were rounded up and put aboard the steamer "Island Queen" and given a river ride to one of Cincinnati's pleasure resorts, known as Coney Island, and initiated into the good grace of New York's namesake. The warm weather which prevailed nearly throughout the whole session made these side trips the more acceptable.

WEDNESDAY MORNING SESSION.

The first session was called to order on the morning of June the 8th at 10 o'clock by President Francis Schumann, with about 200 members and guests in attendance. As in previous years, the visitors were furnished with a numbered badge, though a distinction was made this year, in that members were furnished with badges on which the word "Member" appeared, while badges given to those not affiliated with the Association bore the word "Guest."

Mr. Schumann: Once more I have the honor, as President of the American Foundrymen's Association, to call its convention to order and express my pleasure of again seeing you and tendering my respects. I will open the proceedings by announcing that we are especially honored on this occasion by the presence of some of the representative men of Cincinnati, to whom we are indebted for the hospitality accorded us and who will now address you. Gentlemen, I have the pleasure of introducing to you, first, Mr. D. McLaren, President of the Addystone Pipe & Steel Co., of this city.

Mr. McLaren: On behalf of the local foundrymen of Cincinnati, I bid you a hearty welcome to their city. Conventions of this kind, or assemblages where business men meet together to discuss and to argue their methods and modes of conducting their trade, should make such meetings instructive, and it is hoped by the committee that the members of this Association here present will carry away with them many instructive and good ideas, and that your sojuorn in this city may be of such interest to you that at an early date we may have the pleasure of welcoming you here again

Mr. Schumann: His Honor, the Mayor, signified his wish to greet you, should his official duties permit. Possibly we may have the pleasure of his presence later on. In the meantime I take pleasure in presenting to you Mr. E. P. Wilson, Secretary of the Business Men's League, of Cincinnati.

Mr. E. P. Wilson: I represent an unfortunate accident, of which you are the victims. Unexpected business of an impera-

tive character called to Columbus the President of the Cincinnati League, Mr. Mellish, who is not only locally, but nationally, known as a speaker par excellence, and I rather anticipated that your Chairman might have enough of local information concerning matters in Cincinnati to have commiserated you and saved me the trouble. However, without apology, I desire to say that the Cincinnati League is the standard bearer of the commercial organizations, and thereby they extend to you the hospitalities of our beautiful city. Our President occupies the distinguished position of spokesman-general, is par excellence the leading speaker in Cincinnati in the extending of cordial words of welcome. It is greatly to be regretted he is not here to speak the piece he has spent many days and hours in preparing. Mr. Shears, who is in his absence the custodian of his property, refuses to give me the manuscript, hence in my plain way I beg to welcome you to the Queen City of the West, Cincinnati. In the name of our Chamber of Commerce, our Manufacturers' Club, our Merchants and Manufacturers' Associations and all our commercial bodies, his Honor, the Mayor, and all the voters. I trust I am not encroaching on the rights of any one when I say that the gates of our city are wide open, and the keys are yours. If you find yourself in any position of embarrassment during your sojourn here, and find it difficult to return to your hotel, call for the nearest policeman and mention my name, or his Honor, Mayor Tafel's, and you will be restored to your homes and your fireside. Our distinguished friend, Mr. McLaren, has set me a commendable example, in the brevity of his remarks; but with that hard-headedness and persistence which characterizes members of the Cincinnati League, I fear I am not following it. I omitted to mention that I also speak in behalf of the citizens of Cincinnati. I think they would all like to be here to see for themselves that a body of active, practicable business men, of the most progressive character, representing as we do enterprises of great magnitude, has seen fit to accept the hospitality of the city and hold conference in our midst. I hope to morrow when you are able to float on the limpid waters of our beautiful Ohio—

A voice: "Limpid is good."

Mr. Wilson (continuing): The gentleman is pleased to be humorous in his remarks, but he does not disturb the speaker. I reiterate, that it is our fond anticipation that you will tomorrow float on the broad waters of the limpid Ohio, safe in the bosom of our peerless Island Queen, and inspect one of the most notable and important industries of our city. Gentlemen, when you inspect the wonderful accomplishments you will see tomorrow, which are largely the product of the massive brain of the gentleman who has just addressed you, only time will prevent you from realizing that one-fifth has not been shown you of the vastness and success of our city as a growing manufacturing center. There are a number of gentlemen here who I know can bear testimony to the fact, that Cincinnati stands first in many of the leading industries of our great country. The effort to enumerate them might prove tiresome. I will therefore refer you to our Directory. I feel I have said enough to convince you that you are cordially welcomed by the citizens of Cincinnati. I hope you will enjoy every moment of your sojourn here, and that your deliberations may be harmonious, resulting in the further development of the great industries of our country, which already attract the attention of the world. Our products are to be found in all markets, our flag will be carried to every part of the globe, enabling you to realize that the progressiveness of your country is embodied in you, and your children, and your children's children. I again bid you hearty welcome.

Mr. Schumann: We have listened to the remarks of Mr. Wilson with great pleasure and are additionally favored by the presence of Mr. J. Bowron, Vice-President of the Tennessee Coal, Iron & R. R. Co., of Birmingham, Ala. One of the representative men of the Southern iron industry. Mr. Bowron, gentlemen.

Mr. Bowron: I am very glad to see so many people whose signatures I know. I know them as a rule as being at the foot of either checks or notes. I am not quite sure whether I am in perfect safety this morning, because I have supposed that my

friends here might have so many notes to compare as to the excess of silicon, or the deficiency thereof, that they might use that as a ground for imposing a check on my exuberance in trying to defend the prices of pig iron. I simply throw myself on the mercy of the court, presenting myself as you see under a flag of truce, viz: White suit. Your secretary has very kindly permitted me, not being a technical foundryman, and able to throw any light upon the technical departments of our business, for I am privileged to stand as one of you, a foundryman theoretically, but not practically, has very kindly permitted me to make a choice of subject, and as I have lived in this country for twenty-one years last week, and thus I trust become, as one changes in seven years, threefold an American, notwithstanding the sympathy that ties me to the old parent country from which I came, and as an American have offered two of my sons who are now at the front as private soldiers, not as commissioned officers with soldier straps to decorate them, but boys out of a bank, and out of a college, that they might go as private citizens to do what other men's sons have got to do for the maintenance and welfare, prosperity and glory of our common country. So I am glad to stand to-day, not as an Englishman, except in memory, but as an American, as an Alabamian, and to rejoice in being one of the assemblage made of men from every party of our great country, great as it is to-day, greater as it shall be under the providence of God in the days that are coming! How little we know from day to day as we live that we are making history; how the events that are taking place around us lead us to an open door, from one field to another. We do know whence we came, but not whither we go. How little did I suppose when I came to this country twenty-one years ago and went down in the south, came from the collieries of Durham, and the iron furnaces of Cleveland in the old country, came and located among corn stalks and cotton stalks, how little did I realize that I was coming into the heart of a region which in the brief space of two decades should supply the very country from which I had come, as has taken place in the past month by the delivery via Bremen of Alabama iron

into the very town of Middlesbrough. How strange it seems to realize that Birmingham, Alabama, where I live, is to-day the third largest point of export of pig iron in the world—Middlesbrough, England, being the first, Glasgow, Scotland, the second, and Birmingham, Ala., the third. Within the eighteen months ending first of January last, there were exported from Birmingham two hundred and ninety-seven thousand tons of pig iron to foreign countries. This iron went to England, Scotland, Wales, Ireland, France, Belgium, Holland, Germany, Russia, Denmark, Sweden, Spain, Italy, India, Japan, China and Australia. Now there is something very remarkable in the local conditions which will permit an inland city like Birmingham to ship pig iron in such a way to every part of the known world, and especially to the city from which I came, and which, up to the time of leaving England, was supposed to be and was undoubtedly the center of production of the cheapest pig iron in the world. The Middlesbrough furnaces draw their coke from a distance not exceeding thirty miles, their limestones about twenty miles, their iron ore a distance of six to eighteen miles, their pig iron not from the cast houses, because they do not use them, but from the pig beds under the open sky, and run it down on the little narrow gauge buggies to the wharves, where it is loaded on steamers. In spite of that we load our pig iron on cars in Birmingham and ship it 200 miles to Mobile, and then to every port of the known world. We ship it, as you gentlemen know from personal experience, to every state and territory in the United States, to Canada, and Mexico. Why is it? We have not any better coal than exists in a dozen different places in America. We have no better ore than exists in a dozen different places. We have not got such gigantic bodies of ore lying on the surface to be scooped up by a steam shovel as in the Messaba region; we have not got such ores as are to be found in the Gogebic district. Why is it we can do these things of which I have spoken? The answer is simple. You may take a large size map of the Birmingham district, a map on a large scale, take a straw hat like this and put it down on the iron ore, coal mines and blast

furnaces, and cover it all up. Supposing you would consider these three fingers put together horizontally as representing, if you please, the top one, the carboniferous strata; the middle one, the sub-carboniferous, carrying the limestone, and the bottom finger the silurian measures, carrying red fossil ore. Then take an upheaval of nature, which makes an anticlinal which splits them open and thrusts them over, wash off the top of the iron with water and make a valley, and what have you got?—A valley in the middle and three outcrops on either side, coal, limestone, and the valley between for the railroads to run down the whole of the valley, and blast furnaces and mills everywhere, where side tracks can be put in. When you consider the mileage which is involved in the assemblage of materials for the production of iron in other parts of the world, whether it be the carrying of coke from the Connellsville region, into Cleveland or Chicago, or whether you consider the mileage involved in the haulage of ore from Lake Superior to Pittsburgh, you will see the differences involved economically by turning to compare the haulage of ore in the Birmingham district a matter of six, eight or ten miles into the furnace stock houses. The switching of coke a matter of half a mile, simply having the coke ovens put out of the way of the blast furnaces—when you consider that at the plant of Ensley, in the suburbs of Birmingham, for the purpose of illustration, we found it necessary that our friends the Semet-Solvay Company (who are putting down 120 by-product coke ovens, in immediate contact with the furnaces, and who will deliver their coke without railroad freightage of any kind, simply a conveyor into the stock house of the furnaces) should excavate the coal in order that the foundations should not burn away, then you may realize that standing on the top of the water tower, with one of the rifles with which we are making the Spaniards cringe to-day, you can put a bullet from the top of the blast furnaces into the ore mines; you can take a revolver and fire a bullet on to the coke ovens or to the quarries from which the lime is drawn. Look any way you please for a mile to a mile and a half and we have everything needed to open out. In addition to this we must consider the ease with which the materials are worked. I have spoken of the way in which the ore outcrops

on either side of the valley. The bed of ore, which is continuous, lies at an angle of about thirty degrees. It is opened at a height of about 400 feet above the valley, opened by stripping, working on the outcrop as far as may be desired, and from the first acre of ore which was ever opened in the Birmingham district, being at a point called Redding, the Morris Mining Company, who opened it for the Hillman estate, paid a royalty of twenty-five cents per ton, or $14,000 for the ore taken from the first acre. I have seen that ore forty feet in thickness, top to bottom, worked by pick and shovel. That is, however, entirely exceptional. The average thickness of the ore as worked to-day is about ten feet, and that is a very convenient thickness of working, because if you get above that it makes the timber heavier where timbers are used in mining. This ore you open at the outcrop and run your cross-headings right and left along the axis or longitudinal plane of the mountain. As soon as you have excavated the ore tributary to that opening you drop down 50 to 100 feet and repeat the operation, drive a fresh chute, take all the ore above you, work it out and drop down 75 to 100 feet again. The result is this, that while I do not know what other people are doing nor desire to dwell on what our own company is doing, but because the figures come more readily to my mind—whilst we are taking out about 1,600,000 tons of ore per annum, I looked at the map yesterday and the operation seemed like a scratch on the surface of the mountain. One might consider we have worked out perhaps an amount above water level equivalent to half a mile in length of the lead of the ore. Our own company has twenty miles, and as we have been twenty years working the half mile, we shall be four hundred years working the rest. I may safely promise all the friends here who are accustomed to use Alabama iron in their mixtures that they need not be in apprehension of a cessation in the supply for four hundred years, and by that time we may have found a way to make castings last indefinitely. Now, gentlemen, it has become a very interesting question to us in this country within the past year or two as to what we are to do with our manufactured goods in the iron trade. The constant growth and spread, the

growth in capacity and the spread in every direction of our products has led more or less in other trades, and I presume it must be somewhat the same thing in the foundry business to the getting into each others' way and treading on each others' toes. We have looked with satisfaction on the growth of an export business. Certainly twenty years ago one would never have dreamed of it. Twenty-five years ago the production of pig iron in the State of Alabama was 11,000 tons. Last year it was 840,000 tons, a considerable growth in twenty-five years of time. The expansion of an export business, as it is needless for me to say to an audience like this, lies in the low plane of cost which has been attained. When I first sold No. 3 foundry iron in 1879, I remember the first order I booked was for a pipe foundry, to go into cast iron pipe, and I sold it at $17 delivered at Louisville, and the same iron to-day would be delivered at half the money, $8.50. When we remember that it takes the same amount of ore to make the ton or iron as then, roughly and broadly and generally speaking, it requires the same amount of coke, it is a serious question and an interesting one. Where has the economy come in? On the output of the company I serve, the scaling of prices represents $17,000 per day, and as the furnaces run 365 days per year, that represents nearly $6,500,000 per annum, our product has been scaled in value in twenty years. That economy has come partly by the washing of the ore, putting less silica in the top of the furnace and less slag at the bottom; partly by the washing of the coke, so that it contains less silica and requires less flux, and wastes less calories in the furnace; and by the expansion of production by the equiping of a furnace with engines to drive not at 4 to 7½ pounds pressure, but 12, 14 and 16 pounds to the square inch, so that we get, not forty-five tons per day, as was my first experience, but as high as 250 tons for an every-day product. These are the sources of economy, together with the universal trend of co-operation, the putting of business to business and bringing greater outputs and greater masses of material under one management and one general expense. This action,

it is needless to say, is on the same principle that the foundrymen are giving so much attention to in governing the business by the chemical laboratory, which has played such an important part in the production of pig iron. The blast furnace gas, which in Scotland twenty-five years ago used to flash out into the open air, is now corraled, and the ammonia, tar, naptha and creosote extracted and sold therefrom. It is supposed that the Scottish blast furnace owners make more money from the by-products than from the pig iron which they sell. That, of course, cannot be obtained in this country, where we use not raw bituminous coal, but coke. But what we can do, and what is being done, to facilitate economy in the production of pig iron, is to erect by-product, we have got to the point where we need foreign markets, from the blast furnace gas, but from the coke oven gas. Now with this constant march of economy and constant expansion of product, we have got to the paint where we need foreign markets, and we are taking them very rapidly, not only in iron but in steel; and while this is a meeting of foundrymen, very few of whom produce or use steel, still the two materials are becoming corelated together more and more every day. This is indeed the age of steel. It is a wonderful thing to consider, and a very serious one for producers of pig iron to consider, that whereas the consumption of iron as steel has increased 1,500,000 tons per annum in the last ten years, the consumption of iron as iron in elementary form has decreased 1,000,000 tons per annum. That is one reason why a good many blast furnaces are standing idle to-day. It is not the only reason. All nations are subject to times of delusion and wild ideas. Those who have heard the gifted American lecturer, George R. Wendling, on "Poular Delusions," must remember his vivid descriptions of the South Sea bubble and various other phantasmagoria. A singular delusion swept over this country some years ago which caused a great many people, apparently sane, sober and in right mind, to believe that by the construction of a blast furnace they could turn a cabbage garden or some vacant pine land into an important boulevard of a city, the lots of which were worth at least $1,000 per front foot. So it has transpired that there has been in this country a plethora of blast

furnaces, and in the last ten years many of you have derived an advantage at the expense of the creditors of the blast furnaces which have supplied you with pig iron below the cost of production. And it lies well with you to seriously consider the fact that those days have passed and that creditors, as a rule, however lenient, indulgent and tolerant, come to an end of desiring to throw good money after bad, and to maintain insolvent furnaces in the hands of assignees and receivers solely for the friendly purpose of supplying the members of the American Foundrymen's Association with pig iron below cost of production; the argument of which is sufficiently obvious to those of you who desire to make your mixtures a thing of permanence, must necessarily trade with men who come boldly and deliberately to confront you with these unpleasant truths under the shelter of a flag of truce, and to tell you that if you buy your iron from the Tennessee Coal & Iron Co. you will never fall into the hands of an assignee! I said I would not do any advertising—I am simply philosophising. But now, gentlemen, as I said in the beginning of this portion of my address, the popular delusion about the construction of blast furnaces, necessarily involving a fortune, is responsible for a good many idle furnaces. But the switching off of so large a part of the world's consumption from iron into steel is responsible for a great deal more, and that is a permanent change, and one not only permanent, but increasing. To what extent steel castings may take the place of iron, I am not competent to offer an opinion; but as I am not speaking on that subject, but of the southern iron district which to-day furnishes, I suppose, half of the foundry irons made in the United States, it is a very serious thing, and it is proper that in drawing your attention to this general outline of the district and its situation I should refer to the question of steel. I remember it says in the good book that although Haman sat at a banquet of wine with the king and the queen, he answered: "All these things avail me nothing, so long as I see Mordecai sitting in the gate." He was the fly in the pot of ointment. It avails us nothing that we make cheaper foundry iron than any other concern

in the world, if we cannot get money enough to pay the salaries of the officers on the first of the month, and creditors send their boys around with all sorts of little duns. It therefore becomes necessary to divert the product of the southern district from foundry iron into steel. For a great many years people said you could not do it. I do not know why it is or what we have done in the South to give rise to such incredulity. I do not think Southerners are more prone to magnify their abilities than other people. There is a good deal of "Americanism" about exploiting ourselves and not hiding our light under a bushel. There is no reason why we should not; we have the grandest country to-day under the canopy of heaven. We are not compelled, as the richest country in the world—England—is, to import our food. We are not circumscribed by hostile nations with official boundaries where, if a man is espied on the wrong side of a tree, he is to be shot as a spy. We are protected on either side by the Atlantic and Pacific. We extend from the torrid region to the frozen shores of British America. We produce every kind of food, and feed mankind, and ship grain abroad. The reason why iron men are protectionists is that we know that, whereas the countries of the old world are compelled to get food from us because they cannot raise it for themselves, we can raise enough for our own people and have a surplus for other countries, and compel them, if we desire, to pay us in money or credit, and not in manufactured products on which they would charge us a profit. Let us take their money and make our manufactured goods at home. So we have a right to be proud of our country, and as every man speaks that which he does know, so I as a Southerner, speak that which I know when I say that we have a fine part of this country, and do not say so in any selfish spirit, because this is a free country and Alabama is a free State. In Birmingham we have men come from North, East and West, so no man has any claim to this town of the South over and above another on account of birthright, either the Northerner or the Southerner; it is all one. We do not ask where a man comes from, who was his grandfather, or what has he got. We are practical people, and every man

coming from the North, comes into the land where they are just as glad to see him as one of their own. We know we have got, and you have got, as part owners of Alabama, a fine country. It amuses us, therefore, to see the incredulity with which people have said all kinds of things about our iron from time to time. I remember when going to St. Louis in 1879, to sell foundry iron there, a gentleman said: "What! Tennessee? Alabama? No, no, no. Could not think of such a thing. Would not think of using anything in my mixture other than Hanging Rock charcoal or Glengarnock No. 1." Now we send iron to Hanging Rock and to Glasgow in the place of Glengarnock! I used to see in some of the writings of our Eastern friends, with headquarters in New York, in the journals there, that it was true a little iron was coming, but it would not make any difference—it was only a drop in the bucket—came as a sample—could not afford to send it there—it was an experiment. I have heard of boys whistling to keep their courage up in going through a graveyard; but whistling kept up and the iron kept up, and the next thing we hear was, "Of course these people are putting in their iron, but it is an inferior quality and would not sell as well as other irons." By degrees it got to command the same price, and then they said, "The iron is all right enough, but they are losing money and cannot afford to send it there, and there will be no more of it." We did not shut up, but built additional furnaces and made more iron, and so it kept on. The next thing we heard was, "Of course it is all right for the foundry business, but it is a high silicon iron, and will not do for any mixture where strength is required." The next thing, out of the basic iron we make for the steelmakers in every part of the United States, we see the foundrymen come to us, saying, "Give us of your basic iron, that we may use it instead of charcoal iron to put strength in our mixture." The next thing we hear from our critical friends as to southern iron was, "Of course they may use it in a highly silicious mixture or for strength, but for open hearth steel it will not do; they may take a little and mix it with northern iron, but it is not an iron to make steel of." It looked for a time as if there was a

little bit of truth in that idea, because the southern iron is silicious, too much so for a basic open hearth process, the phosphorus too high for acid process, either Bessemer or open hearth; but by the discovery of limitless beds of dolomite, in one of which I could show you within six miles of Birmingham a face 40 feet deep and extending as far as you would want to run, a dolomite with less than 1 per cent of silica, which is not only suitable for basic additions, but for furnace repairs, and is also suitable for use in the blast furnace, and we carry a sufficient burden of it to keep down the silica. We are able to make basic iron with it and make it down to .02 or 2-100 parts of 1 per cent of silicon in the iron in the blast furnace, and on that account I say we can do anything required for the manufacture of steel. We have therefore run one blast furnace continually for three years making iron for open hearth basic steel works for such concerns as Carnegies, Illinois Steel Co., Park Bros., Jones & Laughlin, A. & P. Roberts, Cleveland Rolling Mill and others. What remains for us to say, as we are saying now, "If such things be done in the green tree what shall be done in the dry?" Let us make our own steel, cease to make pig iron, and ship it to every part of the world—ship it to terra incognita, as well as to such distant parts of the world as Connecticut, Cleveland and other far off places where we have to pay vast sums to intermediate people called "agents" to go around and see consumers. Yet if you would only come down to Birmingham we would pension the agents and give you all free sites for your works! But it is a fact that within the next 30 days, undoubtedly, the papers will be signed which will divert within a year, probably one half of the iron which is now being supplied from the Birmingham district to the founders of the United States, into the steel works which will be there constructed, and there will be a large diminution in the supply of cheap pig iron which is being offered to you from the Birmingham district, unless such a little incidental modicum of profit as 25 cents to 50 cents per ton can be added to the price as to justify us in putting in more furnaces with the large expenditures which that involves. Now then, in conclusion, I want to draw your attention to this—without in the slightest degree working anybody for the moving

of works, as that is a thing I do not believe in; a business which is not worth running where it is as a rule is not worth moving—this business of employing industrial agents to run around the country begging people to remove their plants to other places is all humbug, but there is this consideration which is open to your minds and which I offer to you. Suppose you are making stoves or iron pipe, or radiators or sugar machinery, or any other kind of material which can be exported to foreign countries, it becomes a very serious question whether it is not worth while to look into the situation of the south with a view to establishing a branch of your industry with especial reference to an export business. Now the distance from Birmingham to the sea coast is only 268 miles. The railroads are liberal. We can reach Pensacola by the Louisville & Nashville system, Mobile by the same, and by a combination of the Southern Railway and Mobile & Birmingham, and by a combination of Alabama, Great Southern and Mobile & Ohio. There is easy transport and the roads are liberal in their rates. Birmingham is situated 602 feet above tide water, the weather is pleasant, the climate benign. I lived 13 years in Nashville, and now 209 miles further south, in Birmingham, I can state the climate is milder in Birmingham than in Nashville. Latitude does not count, the elevation does. We have 600 feet of elevation and are near enough to the Gulf to obtain our share of the influx of the cool air which sets in all around the United States to take the place of the vast mass of heated air rising from the great interior of our continent throughout the hours of daylight. So there is always a movement of air which makes it a pleasant place to live in. I say, speaking of railroads, with a fall of 600 feet against 268 miles you see there is an average fall of 2¼ feet to every mile of railroad from there to tidewater. That being in favor of the load, enables a railroad to make extremely low rates, and they carry pig iron and heavy castings to the Gulf for export for $1.00 per ton. Now, then, when you consider the movement of the cotton crop of the United States from southern ports, when you remember that that movement this year was over 10,000,000 bales, and was almost entirely confined to the ports, say four-fifths of it, from New Orleans to Norfolk inclusive, when

you can go from Birmingham to Mobile and Pensacola for $1.00; Port Royal, Savannah and Charleston, $1.75; Norfolk, Va., for $2.21, then you have marvelous opportunity for shipping your heavy iron goods in connection in some cases with cotton and in others coal and coke, to foreign countries. Why, the other day we shipped a cargo, for example, of pig iron with coke on top of the iron from Pensacola direct to Yokohama for $5.00 from Pensacola, a through rate of $6.00. With the enormous growth of manufacturing, with the continual cheapening of the cost of your castings, with the results you are obtaining from the comparing of notes in your foundry associations, not only this one but also in your local associations, from the application of economic chemistry to produce the best results, I insist that you as manufacturers of iron goods are getting into the same position as we who are producers of pig iron. You are getting to the point where you are able to compete with every other foreign nation where the lanes of ocean commerce will enable you to obtain transportation and to move your goods, and I do not know any place in this particular line where a plant can put itself in immediate physical juxtaposition to coal or coke, limestone, pig iron, with a half dozen railroads, with nominal rates of freight to the sea coast for export, and with a river which is now navigable to 40 miles from Birmingham and which, in the course of a few years more, will enable heavy products to be carried to Birmingham or Mobile at a cost not exceeding 60 cents per ton, except in our section. There is a locality which is going to dominate a great part of the world in years that are to come. I believe the consensus of opinion of this country is going to lead to a control of the Philippine Islands now that we have them, and that along with the ownership of that rich and productive spot will give of necessity the Caroline Islands, 2,000 miles nearer to us. I believe when we take Porto Rico we shall keep it. I believe that when the insurgents in Cuba, what few of the poor miserable fellows are left after the cruel oppression they have suffered, the starvation and warfare with the Spanish, may be left, I believe if they then have the opportunity as we shall give it to them of ruling themselves, there may not be sufficient of them to control

it, and they may find it necessary, for the preservation of order and wealth, and preservation against the Spaniards, who remain, to turn it back to us or to have an American protectorate. If these things are done, whether it be so or not with regard to Cuba, the acquisition of territory in the Chinese seas will extend our Pacific border 7,000 miles in that direction, and I am confident that the American nation will never again dare to await the approach of a day of trouble with the risk and necessity of sending an Atlantic fleet a voyage of 13,000 or 14,000 miles in the way our splendid "Oregon" made the trip, and that means the construction of a canal through the isthmus, and the day that the canal is made, while I speak as an American, I cannot close my eyes to the incidental results which will give the Alabama coal fields the control of the Pacific coal trade from San Francisco to Valparaiso, putting steam coal on ships at Mobile or Pensacola at the same price that it used to be put on board at Newcastle or West Hartlepool. There can be no other country which can occupy the Pacific coast as we can, and it will double the value of the Alabama coal fields and the industrial activity that exists to-day; and to those gentlemen in the American Foundrymen's Association who take time by the forelock and plant themselves with the intention of taking advantage of the changes which this war is bringing about, I say they will reap, in my belief, a splendid harvest of reward for their foresight. I thank you exceedingly for the opportunity which I have had to look into your faces and shake your hands as the gentlemen with whom, through the medium of our respected agents, we have in years gone by done so many millions of dollars of business, and I trust with great respect and greatest friendship that it may be our privilege to continue these relations for many years to come.

The Chairman: I hope our stenographer's report of Mr. Bowron's remarks are accurate and full because they are of great value and interest to those engaged in the iron industry of our country. Our Journal will gain in importance and prestige in publishing Mr. Bowron's address complete. Another gentleman with us and one closely identified with the foundry industry is

Mr. L. Kahn of the F. & L. Kahn Bros., of Hamilton, O., chairman of the reception committee, whom I have the pleasure of introducing to you.

Mr. Kahn: Gentlemen—After listening to the speech of Mr. Bowron, who has so well entertained you, I shall take advantage of my modest position as chairman of the reception committee by limiting my remarks to a formal declaration of my happiness in having been selected to perform the delightful ceremony—thrice repeated this morning—of welcoming you to the good City of Cincinnati. The reception committee has been conspicuous, gentlemen, chiefly by its absence until now, and I offer you the apologies of its chairman because its members have not discharged the duties manifestly assigned to us, meeting you with a band upon the arrival of your trains and escorting you to headquarters! You are entitled to more than ordinary welcomes, and to more than ordinary demonstrations of joy, having come a long distance, many of you, to attend this annual meeting, especially on hot days like these, notwithstanding due notice from the weather clerk before you started from home and the important business prepared for your consideration here. I sincerely hope your stay in Cincinnati will be both profitable and pleasurable. Let me assure you that from this moment on every true Cincinnatian will put forth his best efforts so that when you leave this city again you may feel that it was good to be here; that you will like to come again, and that you can with perfect honesty and sincerity and at all time speak words of praise for the old Queen City of the West.

Mr. Schumann: There is one more of Cincinnati's representatives to hear from, one who has been most active in extending to us the hospitality of Cincinnati, having devoted the better part of two days of his time to our enjoyment. He needs no formal introduction. Mr. Meacham is chairman of the entertainment committee and will speak for himself.

Mr. Meacham: Mr. Chairman and Gentlemen—Your president said there was another representative from Philadelphia to speak to you. I suppose he said it because he was thinking of

the "City of Brotherly Love," and before you get out of Cincinnati we hope to make you believe we merit that name as well as Philadelphia. After all these speeches of welcome, it is only necessary for me on behalf of the entertainment committee to say, we wanted you to come and we are glad you are here. We were restricted greatly in our plans for your entertainment, for your secretary told us that this was to be a business meeting, and some time had to be left in which to read the papers on the program. The supply men on the committee could not comprehend it. They employ hundreds of missionaries to tell you how to make your mixtures, what is the matter with your coke, how to perfect your castings, and incidentally to keep you supplied with raw material. Why you should care to remain here and listen to papers when you could be taken sightseeing through the most beautiful suburbs in the world, is something they could not understand. An old student of human nature said, "Talk is cheap." In addition to our verbal welcome there is something else coming. When you return home we want you to carry a host of pleasant recollections, so that this will be a time in your lives upon which you will look back with pleasure, and which will create a desire to visit us again. To-night at 9 o'clock the doors of the large dining room will be opened for the smoker, and you will be provided with all that is necessary in the way of apparatus for smoking; there will be a luncheon and perhaps something to drink. It is to be hoped everybody here will be present to-night. It has been announced on the program that to-morrow morning at 10 o'clock we shall start for Addyston. The time has been changed. The brass band that did not meet you at the station will meet you to-morrow at 9 o'clock, and we hope it will not be too early. We shall march to the wharf and take a ride first up the river as far as we can go in the time allotted, and then turn toward Addyston, arriving there at half-past eleven. There will be no stop of the boat after we start from the wharf. After the works are visited and on the way home a luncheon will be served on the boat.

Mr. Schumann: Mr. Meacham, I hope you will restrain the activity of your entertainment committee sufficiently to enable us to attend to some of our current business, after which we will again be at your service.

The American Foundrymen's Association is at a disadvantage in not having designated some one more capable than myself to respond to the graceful words of welcome we have listened to on behalf of the City of Cincinnati. I but feebly express the sentiments of the Association when I say that we are profoundly impressed with the distinguished reception that has been accorded us. We feel that by the efforts and actions of our entertainers they have environed this occasion with an importance which will greatly increase the prestige of this organization, an organization the purposes of which must meet with your esteem. Our purposes are national and patriotic, we aim for the elevation and advancement of the foundry industry, one of the most important of the country and especially so of this city. Our purpose is to formulate and devise ways and means by which this industry may occupy a front rank when our country enters into competition with the nations of the world for its commerce. We accept the hospitality offered to us with heartfelt thanks, not only for ourselves, but on behalf of the foundrymen of the country generally. Gentlemen, we thank you.

The American Foundrymen's Association has all cause for congratulations in being the recipients of the hospitality for which this beautiful city of Cincinnati is so famed, and which is so heartily extended to us by its citizens and the foundrymen of this section. We deem ourselves highly honored and most thoroughly appreciate the courtesies of our entertainers.

This meeting constitutes the third annual convention of this Association, and in accordance with the usual custom I open the proceedings with a brief address upon matters of more or less interest to you. Before the advent of this Association, or rather the local organizations which immediately preceded it, the foundry industry had virtually no standing as compared to allied pursuits. Very little, if any, intercourse existed between those

engaged in it—on the contrary, rather a feeling of reserve, if not a species of antagonism prevailed, which tended not only to the disadvantage of the individual, but also greatly retarded the spreading of that valuable knowledge so necessary to the progress of the calling. The change in the attitude of foundrymen toward each other, since the formation of this body, has been most marked; they have become acquainted with one another, friendships have been formed, and a desire for mutual respect has been established. The interchange of thought and experience has proven beneficial and broadening, and a desire to merit the approval of his fellows for knowledge and attainments has been aroused in the members. A noticeable elevation in tone both in the individual and the general body has been the result.

It remains for this Association to perfect its organization by the adoption of wise and fair rules, and to await the time when all the foundrymen of this country will and must acknowledge the wisdom of its purposes and aid in placing it in a position of power, which must result in the good of all concerned.

We are rapidly passing through the preliminary stages incident to the formation of any association like ours, especially one composed of members widely scattered over an extended territory.

To those foundrymen not yet joined with us let it be known that the basis of this Association is a solid foundation of broad principles to which they cannot but subscribe as being of the highest importance to the welfare and prosperity of their calling. I appeal most earnestly to those not yet allied with us to inform themselves of the objects and scope of this Association and to make common cause with us in attaining our aims.

The journal of the Association, while not yet matured, contains all the elements of an important factor for disseminating knowledge and information. Even in its present state it meets with general appreciation and its importance as a technical publication is conceded. I would strongly urge that all possible effort be made to enlarge and increase its field as a medium through which every foundryman may give expression to his thoughts and experience.

The intensely active competition prevailing throughout the world for its commerce, which no doubt will continue for all time, leads to the natural conclusion that that nation whose industrial subdivisions or classes possess superior knowledge and practice the most efficient methods so necessary to produce the best at the lowest cost will be the victors in the race. This necessary superiority cannot be acquired by individual and separate or disjointed effort.

In Germany and Switzerland, where such rapid strides have been made in recent years in advancing industries, the success has been due, especially in the former country, to the wise and comprehensive measures of the government to reach perfection—both political and educational—in the workshop and school. In our country the government is passive in this direction, and the same ends can be obtained only through the effort of those directly interested, hence the necessity of associations like ours, which must be relied upon to advance and maintain their respective industries in the lead.

While no extraordinary advances, technically, are to be noted for the past year, some are of sufficient importance to deserve mention. One is the subjection of green sand molds to the effects of a partial vacuum externally during the time of pouring the cast. This has proved most effective in removing the gases generated, does away with the need of venting, no matter how hard the sand is rammed, and produces perfectly sound castings, free from all blow holes; castings of the largest size are thus made. Another is the use of power rammers for closing in around loam molds, and general use. Another is the general use of compressed air as a motive force in operating cranes, travelers, pneumatic chipping tools, sand blast for cleaning castings, molding machines, and so on. Not the least deserving mention is the rapid spread of knowledge in the application of chemical and physical methods in the mixture of irons; likewise the greater attention to methods for determining cost of product.

Where in former years, indeed quite recently, the foundryman gave little attention to the character of his fuel, the amount of the blast in the cupola or the position of the charging door, he now

carefully tests the coal or coke for the amount of carbon or percentage of sulphur; he also has his gauge glass attached in a prominent position to the cupola and cannot get the charging door too high. He is also supplied with a microscope and carefully examines the molding sand and facing. In fact, science is making itself felt in the foundry as well as elsewhere. Aggressive and persistent competition has compelled those fortunate enough to possess the means to apply them for the acquirement of labor saving devices, whether it be a molding machine, pneumatic chipping tool, power traveler, steam heat instead of the old-fashioned coal heating stove, or gas or fuel in the core rooms. The successful foundry must possess modern devices, and it is only a question of time when those that cannot must make way for those that can.

Our association is in a satisfactory condition. Its influence, increasing with its growth in numbers, should continue to be exerted in the maintenance of amicable and close relations between employer and employee, to raise the standard of skill and knowledge of its craftsmen by energetically advocating the universal adoption of apprenticeship systems (heretofore recommended by our committees), and to use all its power for the more general establishment of manual training or mechanics' trade schools throughout the country. It is also within the province of this Association to formulate a code of practice which shall determine the responsibility for defective castings, whether due to improper manipulation by the foundrymen or errors in the design and proportions of the piece in question. Faulty designs are often the cause of warped castings, shrink cracks and initial stress which it is impossible on the part of the foundryman to overcome, thus causing great annoyance and loss and often ending in expensive litigation.

I would also recommend action that will lead to an early determination and adoption of some uniform system in the form and size of test pieces, the character of the test, and also in the methods of obtaining samples of iron for chemical analysis.

You will have an opportunity to listen to the presentation of a variety of interesting papers and to participate in the discus-

sions, which no doubt will be general and exhaustive, and prove an attractive feature of the meeting. Let us pursue the course laid out, extend friendship to one another, be united in action, and we cannot fail to place the foundrymen of America in the lead of all others in skill and achievements.

The Chairman: We are now ready for the secretary's report.

SECRETARY'S REPORT.

To the President and Members of the A. F. A.:

In preparing his second annual report, the secretary of the American Foundrymen's Association is compelled to acknowledge to himself that he is somewhat at sea as to what such a report should properly contain; what might be appropriately inserted and what omitted.

To briefly refer to the value of membership in this Association, and why it should be generously patronized by every foundry proprietor, superintendent, foreman or chemist, would be useless repetition to an audience like this, when the very presence here of those who are in attendance goes to prove that you are fully alive to these facts as anyone.

It may not be, however, amiss at this time to attribute a large amount of the general knowledge in existence and being constantly submitted before the various foundrymen's associations to the inspiring influence of these organizations.

Before their advent, it was but very rarely that a foundryman could be found who knew anything concerning the technical side of his occupation, and what information was in existence was most generally confined to the graduate of the many good polytechnical schools found all through America who had drifted into the foundry business.

Now, however, it is quite different, and practical foundrymen everywhere, whose only schooling has been within the four walls of their shops, have an opportunity to attend gatherings similar in character to this all over the country, or they are able to read very well and complete reports of their proceedings in several trade journals.

The importance of what might be appropriately called a sort of "higher education" among foundrymen is being shown every day in the constant demand for capable foundry foremen or superintendents, who are fully abreast of the times in all that goes to make an up-to-date foundry manager.

No one knows, and no one will probably ever know or be able to estimate the amount of good substantial work the foundry associations of America are quietly doing in the way of spreading an immense amount of valuable information almost every week into the thousands of foundries and foundrymen's homes, the results of the labor and constant study of many of the brightest minds in the business.

Papers have been read before meetings of foundrymen that have taken months of close application and study to prepare, and these have resulted in the propagation of new truths or have effectually dispelled long held erroneous opinions.

Another fact in this connection which must not be overlooked is that while a valuable paper may be read or a topical subject discussed before a comparatively small number of persons, some of them perhaps not practical foundrymen, yet, thanks to the enterprise and appreciation of the trade journals in America, a full report of these proceedings is often laid before the entire foundry business of this continent within a very few days after such a meeting has been held, and the audience of interested persons, originally perhaps a small one, may be extended by this means into the thousands.

This is not confined to America either. Hardly a week passes that an entire reproduction of one of these reports, or a very good synopsis of it, does not appear in some foreign journal, and is read and re-read by hundreds and thousands of our European friends across the water.

While we are as fully aware as anyone that any man who undertakes to learn his business from books or by reading, will never be a practical man, yet by the same rule those who refuse or neglect to read and study the experience of others, or to keep themselves informed on what is being done or attempted elsewhere, will never be a great success either.

Added to this feature, there is that other one which must not be lost sight of or underestimated. The good results from the bringing together and introducing of these men to each other, thus paving the way for mutual confidences, and perhaps permanent friendships among those who may have been not only entire strangers but close competitors.

In many instances we have seen men meet in this way for the first time, who had known each other by reputation for years, who had been at times near neighbors, and whose sole previous knowledge of each other had been confined to a persistent effort to cut each others' prices, inspired to do so at times perhaps, and indeed very often, by the misleading statements of the purchaser, who have been wont to represent that the "other fellow" was always willing to shade his prices a little.

We know that there are those (and they are a considerable number) who belittle and scoff at the work associations of this character do or attempt to do, but very frequently their lack of confidence arises from a lack of enterprise, and in nearly all cases it will be found that those who express themselves in this way have always done the least towards making them successful.

An association of this character can find plenty to do in encouraging research among its members and others, and by fostering a laudable and amicable spirit of rivalry, it may be and should be the means of bringing forth and making public much valuable information.

It can promote good fellowship and mutual confidence, aid in the interchanging of views, experiences and opinions and on occasions such as this, add greatly to the pleasure and profit of its members.

No manufacturer, and no man in this world, is independent of his fellow-men, and the greater the extent to which we all realize this and are willing to live up to it, the greater the chance of success.

I feel that what I have said is perhaps not new to many here, but I desire to emphasize the fact that I am confident that sooner or later the work being done by this Association must be even better appreciated than it now is, and that every foundryman in

this country will realize that he is recreant to his own interests if he fails to do his share in supporting it or some association in his immediate vicinity.

In this connection your secretary would like to suggest the advisability of establishing close relations between this and local foundrymen's associations in this country.

At the last meeting of this Association a committee was appointed with full power to act for the purpose of doing all in its power to facilitate the formation of an association to be organized for the purpose of "standardizing" the methods now in existence for obtaining amicable adjustments of those disturbing questions which frequently occur between foundry employers and foundry employes.

Growing out of the work of that committee, an association has been finally organized known as the National Founders' Association which, it is hoped by its founders, will be able to accomplish the same phenomenal successful results as have crowned the efforts of the stove manufacturers of America between the date of the organization of their association and the present time.

It is not our purpose, however, to refer to that organization in any way further than to say that if it were not for this Association it probably would have never been successfully completed, at least for many years to come, and the good work that has been done and will in all probability be done in the future, would have been greatly delayed. It must exercise a very salutary influence and be of inestimable benefit to the foundry business of the country, and there have been those of our members who have regarded the matter in such a favorable light as to say if this organization never did anything else during the entire period of its existence, this one thing would more than pay for all the efforts that have been expended upon it.

It has cost our Association something, but it is hoped that this will more than repay many times over, the business as a whole during the next few years.

The thought is not an original one by any means. It has often been referred to before, and while the idea has not yet seemed to take root in some quarters, it would seem to the writer

to be indispensable if the greatest good would be accomplished.

Since our last meeting the Association has added 70 active and 10 associate members to the roll, and the receipts and expenses have been as follows:

RECEIPTS.

June, 1, 1897:	
Balance on hand	$ 15.35
Dues	2,368.00
Journal	35.00
Total	$2,418.35

EXPENSES.

Salaries	$ 597.60
Rent	180.00
Printing, Journal, circulars, papers, stationery, etc	847.27
Engraving	132.69
Postage, telegrams, etc	246.03
Total	$2,003.56

Balance.....$414.79, June 6, 1898.

In conclusion the secretary would like to express his appreciation of the courtesy of those who have volunteered to prepare and read papers before this meeting. All who have ever undertaken anything of this sort will appreciate the work that has been done in our behalf.

JOHN A. PENTON, Sec'y.

The secretary announced that invitations had been received from the S. Obermayer Co., J. D. Smith Foundry Supply Co., Hill & Griffith Co., Bickford Drill and Tool Co., R. K. Le Blond, the Lodge & Shipley Machine Tool Co. and the J. A. Fay & Egan Co., asking the members to visit their works during their sojourn in the city.

Mr. Schumann: After recess it is the purpose to devote ourselves closely to the presentation of papers with the discussions thereon, hence it will be well to get rid of our routine business.

The next in order of business will be the appointment of a committee for the nomination of officers for the ensuing year. I think that is what we did last year. I would suggest if it meets the approval of members, that local organizations meet and designate one of their members to act as a member of the nomination committee, and that the president, in conformity to the usual custom, appoint two members at large to act on that committee. I would like to hear expressions of opinion on this point. Mr. Bell, what is your idea of proceeding?

Mr. Bell: I heartily concur with your suggestions, and if a motion is necessary I will make it as simply a request of the chairman. I think it will go without any motion. I suggest that each local association be requested to hand in the names by a certain time and then you can make the appointment of the committee.

Mr. Schumann: It strikes me that would be eminently representative. Mr. Secretary, I think you had better arrange a list of names of those from each locality and notify them that they should sit as a body, and that they shall designate one of their number to act as a member of the nominating committee. If there is no objection we will consider that to be the course adopted.

Dr. Moldenke: I think the individual associations had better hand in to Mr. Penton the names of two of their members.

Mr. Penton: I will suggest this way. It is the chairman's idea that the members of the four different local associations, New England, Philadelphia, Chicago and Pittsburg; should get together while in the city and nominate one of their members to serve on the nomination committee. Also that they should suggest some one to serve on any other standing committee, as, for instance, to serve on the committee to amend the constitution and by-laws.

Mr. Schumann: That was it. And to appoint two members at large who are not members of any association. If there is no objection we will consider that method adopted, and the various local organizations will please notify the secretary whom they

have chosen to act for them, and do so if possible by this afternoon, because there is generally a great deal of delay in connection with the closing hours of a meeting like this. Likewise it would be a good idea to have the gentlemen constituting this committee to suggest modifications or amendments to the constitution if found desirable. Is there any further business?

Mr. West: Under the head of new business I wish to bring forward the question of the need of greater uniformity in analyses, and as the chairman of a committee appointed by the Pittsburg Foundrymen's Association make a report here, as to the progress made on the subject, in the hope that this National body will indorse the same and give us encouragement to proceed further in the work. Last April I read a paper before the Pittsburg Association illustrating and discussing the variations which are liable to be found by an analysis of one sample in the laboratories spread over this country. A study of that paper showed that there was a difference in extremes to the extent that if one foundryman had been working under one of these extremes and, as a comparative measure, should go to the other he would by using his past experience have injured or lost most all the castings he might have made. That is, in two-thirds of the line or specialties of castings manufactured in this country, showing us that this evil is a very serious one and one on which we should take some steps towards reforming. This committee was authorized at the Pittsburg meeting to proceed with the work as far as possible, and in the short time they have been in existence they have secured the orders of indorsements of 25 of our leading laboratories. This has been very encouraging and really more than we could have expected. To bring the matter properly before this convention a memorial has been outlined by Dr. Moldenke, and I would kindly ask Dr. Moldenke and Mr. Frank, members of this Pittsburg committee, to express themselves further in the matter. I will ask Dr. Moldenke to please read the memorial.

Mr. Schumann: The afternoon session begins at 2 o'clock and it is now late. I would suggest that the memorial immediately follow the paper on standard systems of test bars; it is

then within the power of this body to adopt any recommendations made. I think this will be the best plan. The time is too short now to do justice to the question. If there is no other new business for this morning's session it will be in order to move a recess until 2 o'clock this afternoon.

(Motion duly made, put and carried.)

WEDNESDAY AFTERNOON SESSION.

The proceedings opened with a paper by P. W. Gates entitled "The Molder of the Future."

THE MOLDER OF THE FUTURE.

By P. W. GATES.

The subject "The Molder of the Future and the Need of an Adequate Apprenticeship System" is one which has been given much thought. In making these remarks I do not pretend to do more than offer a few suggestions, which I hope will bring out a full discussion, and thereby give us the thoughts of members who have given this matter a great deal of study, from which it may be possible to organize an apprenticeship system which may be something like uniform throughout the States, and tend to raise up a class of molders of intelligence, calculated to meet the demands of a rapidly growing industry.

If we are to draw our conclusions of the molder of the future by comparing the molders of the present with those of the past, it becomes evident to me that steps must be taken to induce young men to embrace this trade of sufficient education to readily grasp it on different lines from those followed in the past twenty years. Otherwise the business will suffer to such an extent as to make manufacturers untold trouble. That we had better molders in the past than at present is accounted for in the fact that foundries as a rule were smaller and did a more general class of work, it often being the case that foundries employing not more than ten or twelve molders would manufacture plows, stoves, printing presses, water wheels, steam engines, both stationary and marine, saw and grist mill machinery, reapers, mowers, threshing machines, etc. The young man who was fortunate enough to serve an apprenticeship in such a place certainly gained a general knowledge that stood him well in hand wherever he went. But the growth of this business in America has been so rapid that it has brought about the specializing of the different branches, and in doing this at once destroyed the opportunity of making the same high grade mechanics as was turned out in the general foundries. This specializing is carried to such an extent that in hiring a molder now it becomes necessary to ask him what line

of work he is accustomed to; while in the past the bare statement that the applicant was a molder carried with it that he could make any class of work. I have heard it argued that specializing must continue until finally there will be shops making nothing but cylinders, others making nothing but engine frames, others nothing but fly wheels, and that it will not be necessary to have apprentices, as common laboring men can soon be schooled to make any one piece cheaper and to greater perfection. I cannot take this view, but believe the general foundry will always occupy the largest place, at least in number, and to my mind the molder of the future must be different from his prototype. He must have a good education to begin with, so as to be able to study properly the material he is using. In the future pig iron will be known by its properties; so with sand and all other material the molder uses. Hence the ignorant boy who formerly made a fairly good molder will have no place in the strictly modern foundry of the future.

Speaking now of apprentices in general, for all branches are equally affected, I think it will be conceded without much argument that the more intelligent a class of mechanics becomes, the higher the standard of the work which they produce, and the higher the moral tone and self-respect of such class. It seems to me necessary for the foundrymen and manufacturers generally throughout the country to encourage and employ apprentices, for the sake of supplying the places of journeymen who fall out of the ranks through sickness, death, etc., and to supply the necessary molders for new industries. It, therefore, seems desirable to me that young men of education be induced to seek this vocation as a means of livelihood.

If this is the fact, the question then arises as to how we may secure such apprentices. The experience in our works has been that it is very difficult to induce young men who have passed the grammar schools, or schools of equal or higher standard, to embark in the molder's or other trades. There seems to be no difficulty in getting plenty of applicants of an uneducated class, but our experience in the past has been that this class are not

willing to submit to the necessary discipline, and if they are, they are usually dull and slow to learn. On the other hand, we have found that where we could get applicants who had been through the grammar schools, or other equally good schools, they appreciated the fact that discipline must be enforced, were always willing to live up to the rules, were anxious to advance themselves, and were students in their new vocation, as well as they must have been at school, in order to have passed through it. Having acquired the habit of study, we find that they apply the same thought to their work, can readily grasp the instructions given by the foreman, and are not satisfied with merely getting through with their work as a stint. On the other hand, they study the conditions and take great pride in the character of work which they are turning out. From this experience, we have reached the conclusion that we shall try to confine ourselves to a class of apprentices who have at least reached as high a standing as to pass the sixth grade in the public grammar schools, and, if possible, who have graduated from the grammar school or some school of equal standing with the public schools of our city.

In casting about for the reason why we do not have applicants from this class of young men for apprenticeship we reach the conclusion that the inducements offered are too small, and therefore decided to offer a better scale of wages and inducements, for several reasons. First, in many instances the parents of would-be applicants of this kind are mechanics who have had a great struggle to give their children the benefit of a grammar school education, and who, having other children coming along who are gradually absorbing more of their means, feel that as soon as the boy has passed the public school, he should be in condition to be self-supporting, and cannot therefore afford to contribute much if any toward the support of the boy for a further term of two or three years while he is passing through the earlier stages of his apprenticeship. On the other hand, it is natural, and in one sense creditable to the boy, that he should wish to be self-supporting, and also only natural that he should

desire to earn enough so that he may have some small amount of spending money. These desires, we think, often blind the boy, and perhaps the parent as well, to the fact of the reward when the apprenticeship is done, and the possibility that the boy may find some employment which will earn him something like $1 or even $1.50 a day at once, although it may be nearly as high an amount of wages as he will ever reach, decides him to go in this direction.

I know a number of young men who attended public school with me when a boy who are to-day in positions such as street car drivers, conductors, teamsters, etc., who I remember as bright boys in their studies. Some of them have told me that the mistake of their life was in not having learned a trade, and I feel sure some at least would have been able to have earned much more money than they are now earning, and perhaps been high in the offices of some good institution, had they learned a trade thoroughly.

I am sometimes inclined to agree with a friend who once asserted that no one ever learns anything from experience. Be that as it may, young people are slow to profit by the experience of others, and since the fact remains that we do not seem to get many applictions from desirable apprentices, we set the foregoing reasons down as being responsible for the fact, and adopted the following standard:

We refuse to take any applicant who is not to appearances physically sound, cannot bring good recommendations as to character, has not passed through the public schools at least as far as the sixth grade, or of some equivalent educational institution, and is willing to serve three months on trial before signing articles for a four-years' apprenticeship; the three months of trial, however, being counted as so much time on the first year.

A year is to consist of 300 days of 10 hours each, and for
The first year we pay 7½ cents per hour, or $4.50 per week.
The second year we pay 10 cents per hour, or $6.00 per week.
The third year we pay 12½ cents per hour, or $7.50 per week.
The fourth year we pay 15 cents per hour, or $9.00 per week.

The week consists of 60 hours, and it is our policy to give the apprentices full weeks, even if the machinery is not running, by placing them at such times on work that can be done without the use of power.

This scale of wages was made with the idea that it would be nearly if not quite the equivalent that any would-be applicant would be offered if he were going out to find work of a general character, and would therefore be attractive to applicants. We offer a further inducement in the fact that we agree to give each apprentice at the end of his apprenticeship the sum of $100 as a bonus for the faithful performance of the contract entered into between us. We are of an opinion that from an economic standpoint we might do better with journeymen at journeymen's wages, but we also believe that it is a duty which we owe to ourselves, and to the manufacturing fraternity to keep up an apprenticeship system which will develop good journeymen, and we feel that if we do this, and other manufacturers do it, we shall be able to supply yourselves in the future with mechanics of such class as will be better qualified for the work demanded of them, and in this manner be indirectly repaid for the outlay.

We require of our apprentices that they attend night drawing schools so that they may become competent to make ordinary sketches, and help them to learn how to read drawings, and it is our policy to interest ourselves in these matters to a large extent in order to encourage the boys in the greatest degree. I am pleased to say that we always find the class of apprentices of which I have been speaking not only willing, but anxious to avail themselves of such facilities, and that the foremen take great interest in such cases and are always willing to help the good work along.

Not only has our experience with apprentices who have passed the grade of public schools been satisfactory, but in instances where we have had apprentices who are graduates of the technical or training schools, we have found their progress rapid and their ability equally greater, and for this reason we place such graduates in a separate class, offering them apprenticeship posi-

tions which omit the first year's work, and starts them on the second year. We feel that we can do this for two reasons: namely, they have, through practice received at the training schools, acquired some ability, which lessens the amount of attention they need from the foreman; second, a superior educational training and discipline incident thereto fit them to progress faster and accomplish the same results, or better, in the shorter time. The Western Foundrymen's Association adopted a form of agreement for apprentices in which some such distinction was made, but for some reason it has never been put into active operation by its members.

It seems very essential to me that the apprenticeship matter should be given careful consideration by this Association if we have any regard for the molder of the future, and that it should be the duty of every manufacturer to increase his apprentices to the fullest extent consistent with circumstances. In our machine shop we employ 14 apprentices, in our millwright shop one, our pattern shop one, and in our foundry 10. And it is our policy immediately to put in a new apprentice as often as an old one drops out, for the reason that we advise all our apprentices as soon as their time is out not to remain in our shop, but to go out and get the benefit of experience from other shops, believing that sooner or later more or less of them will return to us more efficient workmen than ever.

There is one other matter which I might with propriety call to your attention in this paper: namely, the advisability of cooperating with the training schools in the conduct of their work shops. In talking with the principal of the Lewis Institute of the city of Chicago, on this matter, I asked him whether it would be of advantage to him if a committee from the different branches of manufacturing would call at the institute, say once a month, and inspect the work going on in the shops, and offer such suggestions as would seem to make the work practicable and available for use in such manufactories when the students were out of school. He informed me that he should hail such an arrangement with delight, and that it would be of the greatest

benefit to both the faculty and scholars. It seems to me, therefore, in such light, that it is the duty of associations to take up such matters, as committees of this kind, drafted out of members of associations, would not entail a hardship on any manufacturer, would cause regular attendance and would be of the greatest benefit to all concerned. It is possible that such matters had better be left to the local organizations throughout the country, but as most of the members of this Association are members of some local organization it may not be amiss to mention the matter here.

Mr. Schumann: The paper by Mr. Gates reminds us of the fact that this Association promulgated a year or two ago a form of apprenticeship agreement. That agreement went through careful revision by some of our ablest members, but for some reason or other it has been lost sight of. Nevertheless, Mr. Gates' paper indicates that the necessity for doing something to create practical foundrymen is in force to-day just as strongly as then. The paper is open for discussion.

Mr. Frank: Mr. Gates makes a distinction between the foundry and machine shop. Does he consider all boys eligible, or is there any grade?

Mr. Gates: None at all.

The Chairman: I saw some of the most beautiful castings when in Europe last summer, and one of the most magnificent foundries in existence, such an one as would cause a boy to choose the foundry business. The cleaning shed floor was as clean as that of a dining-room—an exhaust fan kept it in good order. The whole foundry was managed on a most complete system, and the son of the owner of the establishment, a person who in our country would be considered very wealthy, after graduating from college served four years in the foundry, beginning work at 7 o'clock and stopping at 6 o'clock. His initiation into the foundry practice was due to the fact that the owner of the establishment (it having been in the family for generations) realized that the money was made or lost in the machine shop. Dr. Moldenke, we will now have your paper, "The Adoption of a Standard System of Test Bars for Cast Iron."

Dr. Moldenke then read his paper, as follows:

THE ADOPTION OF A STANDARD SYSTEM OF TEST BARS FOR CAST IRON.

By DR R. MOLDENKE.

The expansion of the general iron trade within the last quarter of a century has been phenomenal, and is bringing with it the natural demand for further and greater efforts on the part of those engaged therein. Raw materials, as well as finished products have been cheapened to an extent which makes our veterans sigh for the good old times of war prices; but the demand for quality has kept pace with the requirements of a more commercial character.

To-day a manufacturing founder who uses finished steel in connection with his castings when assembling his product, demands, or should demand, guarantees from the mill which will ensure for him the best material for his purpose. Competition will give him this at market prices if he knows what to ask for and how to ask it.

Similarly the manufacturer who buys castings has a right to ask for and receive the highest product of the molder's skill, combined with a material best suited to the work and the service it must endure. How shall the consumer know when he is getting the best castings for his purpose, or the founder that he is making them and is thus holding his trade. So far as the material is concerned, only by some means of comparison with well selected standards.

The fact that the knowledge and consequent use of such standards is as yet in a very crude state, as indeed are also the methods by which such comparisons are made, will in a great measure account for the many disputes between buyer and seller, leave the foundryman in constant anxiety regarding the behavior of the material after it leaves his eyes, and will sometimes make him feel that the quality of his daily product is a matter of mere guesswork.

It may not be generally known that now and then a contract awarded on given quotations is refused when it is learned that such and such an inspector is to look after its performance. An

additional percentage is asked for to cover the expense incident to the unnecessary and vexatious demands such a man is notorious for making. This is in a measure due to differences in the interpretation of contract clauses not based upon definitely specified tests. Instances of large consumers of foundry product laying down laws of their own are multiplying. The intentions are usually fair, but those who know what manipulations a test bar may be made to undergo, sometimes find competitors taking advantage of this fact; or if compelled to work under specifications not suited for the purpose, will soon realize the uncertainty existing, and frequently have good castings condemned on the strength of a poor system of tests.

Early attempts at securing uniformity in testing materials for structural purposes emanated from the parties most interested, not only great consumers, but the actual owners of the works turning out these products. The supposedly disinterested portion of the trade, the practical investigator and the scientist, is only now coming to the front as an aid in solving problems well known to exist but not easy to fathom out.

A real need exists for means of comparison with standards by uniform methods. To quote from the report of the famous Munich convention, "it is universally acknowledged at the present day that the testing of materials of construction for their mechanical properties can be productive of comparable results, but only when made in accordance with uniform testing methods."

The question of selecting the proper standards of quality is one foreign to this paper. Every man makes them for himself, if indeed these standards are not made for him by his customers. It is the aim of every progressive foundryman to know not only what kind of material his competitor is turning out, but also to see that he himself is doing at least as well. The method by which he may be reasonably assured of his standing as a foundryman, so far as the quality of the iron in his castings is concerned, is the study requiring our more immediate attention.

In matters relating to the founding of iron commercially we are undoubtedly ahead of European practice. This fact is shown

by the immense and intricate castings for dynamos made here readily, whereas in Europe forgings of ingot iron, or low carbon steel, as we call it here, are found necessary to give satisfactory results. When it comes to a close study of the material we are working with daily, however, continental Europe at least is pushing us very hard.

It would carry us too far to go into the history of progress toward uniformity in methods of testing iron and steel. So much can be said, however, that not only has the work of unification been carried on by individuals and societies here and abroad, but commissions have been appointed by various governments for this purpose, and especially now does there seem to be some prospect of success, as nearly all concerned are uniting their efforts, and contributing their experience, for the general good through the medium of the "International Society for the Unification of the Methods of Testing Materials of Construction."

It remains for us to look more closely at the present status of the testing question from our standpoint as foundrymen, to see what information of value we may derive thereby, and how we can contribute our share to the general understanding of this most interesting material—cast iron.

Through the courtesy of the eminent metallurgists, Dr. Wedding and Prof. Martens, of Berlin, I have obtained information regarding the German practice, which is also said to be in current use in continental Europe. In substance it is as follows: Test bars 1 1-5″x1 1-5″ in cross section and 44 inches long are cast in dry sand molds inclined 1″ in 10, the runner acting as feeder and pressure head corresponding to a vertical height of 8 inches. An extension 1″x1″ is cast on the bar from which 1 inch cubes can be cut for compression tests. Of the 44 inches only 40 are intended for testing purposes, the transverse being the first method applied. For this purpose three of these bars are taken and their resistance to bending up, to rupture, together with the corresponding deflection noted. Two test pieces are turned up from the broken parts of each of the three bars for tensile tests, each piece being 8″ long and 4-5″ in diameter. Furthermore six compression tests are made with cubes cut from the broken test

bars above mentioned, two from each bar, the pressure being applied as if the original piece were used as a column.

Two points of special interest to foundrymen are added as foot notes by the commission which labored to draw up these specifications. The regret is expressed first that the area of cross section of these bars is so small, and second that sufficient experience in casting bars on end is lacking. This would seem to imply, and rightly, too, that this method of casting is the preferable one. Without wishing to be critical I might add that the neglect of a proper regard for the teachings of experience in both of these directions will prove fatal to any testing system which may be devised.

While tests similar in part to the above are in use in isolated instances in England and America, yet the testing of cast iron so far as a uniform system is concerned is in a truly chaotic state. Indeed the famous metallurgist, Mr. Hadfield, of Sheffield, writes me deploring the lack of uniformity in this regard and wishes us success in accomplishing something of practical value in this broad and imperfectly cultivated field.

It is, however, not to be understood that there has been a lack of practical and hard work in this direction by our investigators. It is with considerable trepidation that I address you on this subject, when I review the voluminous and excellent work brought out especially in the last few years, by the members of our engineering and other societies from the more practical standpoint, and our professors from the purely scientific in addition. Indeed the foundation of what knowledge of the properties of materials I myself possess, was laid through the remarkably clear and thorough instruction of Prof. Hutton, whom you all know. Looking over the scope of the work done by the society of which he is secretary, and Messrs. Henning and Keep of its committee on testing methods, one is struck by the great mass of results obtained. Then again the Mining Engineers have among their transactions excellent literature on the physics of cast iron. The Civil Engineers, who have done much in the direction of standardizing methods, the rail sections and chemical methods for instance, are awaiting at the present time the action

of the international society regarding further extensions of this work. Then come our independent investigators, Mr. West, for instance, who not only bring out new lines of research, but help by their well meant criticism and effective counsel and work, to stimulate the larger bodies into higher planes of effort.

Thus we see there is a live and healthy movement in progress, in which it seems to me the time has come for us foundrymen to take part. At the outset I will say that there is only one way to ultimate success, and that is through a hearty cooperation with all engaged in similar lines of work. While we all look to an ultimate settlement of the testing question through the authority and standing of the international society, of which I sincerely hope we will become a member shortly, yet it is absolutely necessary that the pioneer work be done in national circles first, and the data thus collected and digested be submitted to conference committees of the international society for final adjustment and promulgation.

The question of testing cast iron is not as simple as it looks. A thousand and one items have their influence upon the ultimate result. Take the constitution of the metal in its broadest sense, and you have essentially a mineral which may, but very likely will not, be uniform in its structure. Some portions then are bound to be weaker than others, and to my mind only a plentiful multiplication of these variations, or in other words a good big cross section, will give approximately correct results. These points as well as many others of interest and importance have been ably brought out by Mr. P. Kreuzpointner recently, and will be drawn upon freely further on.

We all recognize the fact that after all the judging of quality in a material by means of test bars can only be a relative one. Steel, after casting, is subjected to a variety of heat and working processes, leaving the structure of the finished product in a very different form from that of the original. Cast iron on the other hand remains just as cast. As there is no possibility of wiping out the chilling effect of the mold, the variation in structure due to casting temperatures, rate of cooling, etc., the test bars by which a casting is to be judged should approach as nearly as

possible the peculiar conditions obtaining at the time. Is this possible or practicable? I fear not. And this is why there is such a diversity of opinion on the subject among practical foundrymen.

A review of the results obtained by the committee on testing methods of the American Society of Mechanical Engineers corroborates this, the discussions showing that while the results themselves can and will stand upon their own merits, their interpretation is by no means settled, and will change as our insight into the material becomes better. It is therefore very proper that the final report should be delayed until all the data are thoroughly digested and every hiatus is filled out by the results of new lines of research.

What we foundrymen want just now is some system which will become quickly available, based if possible upon the experience already at hand, or requiring only a short time to perfect. A system which is cheap, quickly and easily carried out, and which gives trustworthy results. It has always struck me that the existing methods are not practical enough. Thus the German specifications present difficulties of a serious nature. Casting 44 inch test bars of so small a cross section is not likely to give reliable results. The compressive tests of cubes of cast iron are not often carried out in this country, although cast iron is essentially the material best suited for compressive strain. Test bars turned down from square bars to round ones only 4-5″ in diameter will have four hard and four soft spots, so to speak, in the circumference of their fracture area. On the score of reliability and cheapness the German system therefore leaves much to be desired.

In daily foundry practice, when a contract for regularly furnishing certain kinds of castings is received, it is customary to break up the first one made to detect, if possible, any weakness due to the methods of molding employed. At the same time the iron used, the methods of pouring it, etc., come in for their share of close scrutiny. If this is not done the lesson is liable to be brought home very soon by the customer. Railroads do this with their car wheels, axles, couplers, etc., as a regular method

of testing the quality of the material on which so much depends. While this is the best way to assure oneself of the actual condition of affairs, the thing is not always practicable in the foundry trade. The next best method would be to cut out test pieces from finished castings rejected for some surface blemish not due to extremes of temperature of the iron poured. An opinion must now be formed as to the quality of the material and its adaptability for the purpose intended, and whatever system of testing is used for the daily work, this trial should always be made whenever expedient, to establish a relation between the general run of the metal and the actual results.

Now as to the regulation test bars which should show the quality of the material poured into castings. I will say at the outset that in my opinion a system involving the reproduction in every detail of the conditions coincident with the making of a casting, though very desirable, is a simple impossibility, and no reconciliation of opinions herein need be attempted. The only solution possible seems to be in avoiding as many of the disturbing influences as possible, and in this way aim to get the value of the material poured into the castings while in its best condition, rather than to obtain a poor imitation of the actual work. Good iron can easily be made worthless to a customer through poor molding and casting methods, but it would be folly to expect good castings with poor iron.

For the tensile test then a bar should be round and of a large diameter. The peculiar requirements of the transverse test seem to demand a square and thick bar. Test bars should all be cast vertically to avoid the variation in strength in the upper and lower sides when cast flat. The effect of a dry sand mold should be obtained to remove all disturbing influences due to the varying dampness of green sand molds. These are a few of the points to be considered in the making of the test bar, its preparation for the machine requiring further study. It remains for us to strike the best average of these variables, which from the nature of the case cannot be converted into constants, and this brings me to the following recommendations:

First: That the American Foundrymen's Association authorize the appointment, by the president, of a committee on standard specifications for testing cast iron.

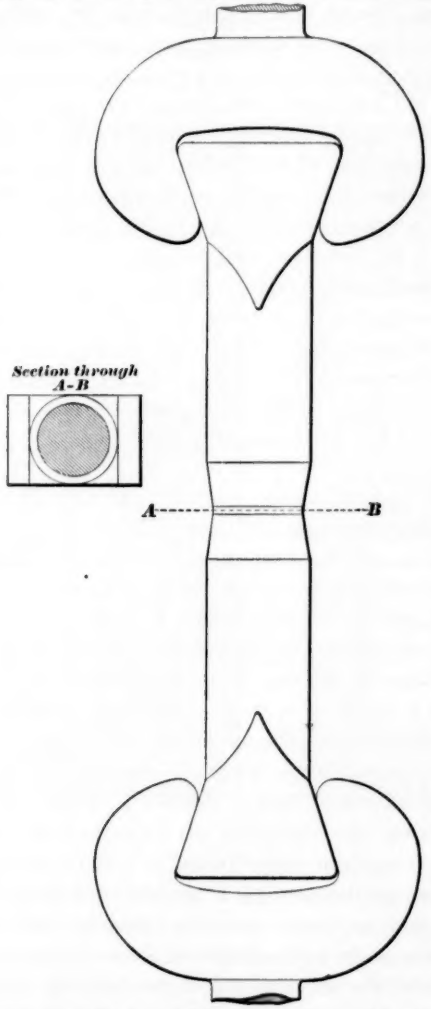
Second: That the American Foundrymen's Association becomes a member of the International Society for the Unification of Methods of Testing Materials of Construction; following in this respect the example of all other large societies interested in industrial progress.

If I may be permitted to add a few suggestions concerning the work of such a committee, I would advise first of all friendliness and co-operation with all others engaged in the same lines of work. Next a careful study of the results already published, and a tabulation of what in the light of our present knowledge of cast iron is of real value. In the meantime a discussion of this subject by the various local foundrymen's associations would doubtless bring out much of value from the personal observations of the members and their friends. Some experimenting will be necessary, and plenty of hard work will surely fall to the lot of those honored by a call of this kind. It will be desirable to have a report prepared for our next meeting, even if not complete or wholly satisfactory to all; for what the foundrymen want is an immediate result in some definite direction. A report of this kind, if of sufficient value, can then be adopted tentatively pending further enlargement or improvement until finally merged into an international code for testing cast iron, in which I hope our American foundrymen will be heard from.

Should such a committee find time to enlarge the scope of their work more on the lines of the committee of the Mechanical Engineers, it might take up the question now being studied and warmly recommended to us by Mr. Henning, namely the relation of expansion during cooling, and temperatures of cast iron. This and other questions relating to cast iron while fluid, during "set," and in cooling, would bring out a fund of information not easily obtained through individual effort.

It would not seem right for me to conclude this paper without offering some idea of a practical kind as a suggestion to those interested in physical investigations. It has for many years

been my observation that a long test bar broken near one end and tested again, would give higher results than before. I have



been able to repeat this up to four times on the same bar, the final result being a goodly percentage higher than the original

test. Now for steel and wrought iron, Prof. Howe has ably discussed this phenomenon, and his "jog point" has become familiar to all testing experts. For cast iron, however, where the elastic limit is very close to the ultimate breaking strength, the elongation being for practical purposes a scientific curiosity, this cannot hold in so full a measure, and the test bar simply breaks at its weakest point. We get then not a measure of the quality of the iron but simply that of the weakest spot of that particular test bar. Test the bar again and the next weakest spot is shown, and so on, until a fairer approximation of the actual conditions could be realized if the bar were long enough.

It was with great pleasure, therefore, that I saw in Mons. Barba's investigations a possible way out of this difficulty. He takes his test pieces and notches them deeply, so that they must break at a given point. The probabilities are that this spot is most likely representative of the whole material, and not one of the weak places, a fact borne out by a wide range of experiments on iron and steel.

I would suggest now that this system be tried for cast iron with this difference, however, that a test bar representing castings not to be machined should have the slight contraction provided for in the pattern, and for castings which require machining, the straight test bar should have a narrow groove turned into it. The accompanying cut will explain my suggestion more fully.

Fig. 1 shows the test bar in position for the tensile test. The contraction is shown at A B. It is only 1-4″ smaller in diameter than the balance of the cylinder, and is made about 1-8″ in length in order to overcome the difficulty experienced in obtaining a perfect V groove in a casting. When the bar is to be machined, as stated above, the contraction AB is omitted and the V groove turned into it before testing. It will be noticed that the ends are flat and taper outward, so that a bar may be held in solid clamps and be adjusted to receive the strain centrally. Since the taper is only on two opposite sides of each extremity of the bar, by laying it upon one of the other two, a transverse test may be carried out. Moreover this arrangement makes the molding comparatively easy.

An experiment made with a bar of this kind, and another of a uniform diameter equal to the contracted portion of the first, both bars cast in the same dry sand mold, showed a slight difference in their fractures. The contracted bar broke at the center and was coarser grained at that spot than the other straight bar, which

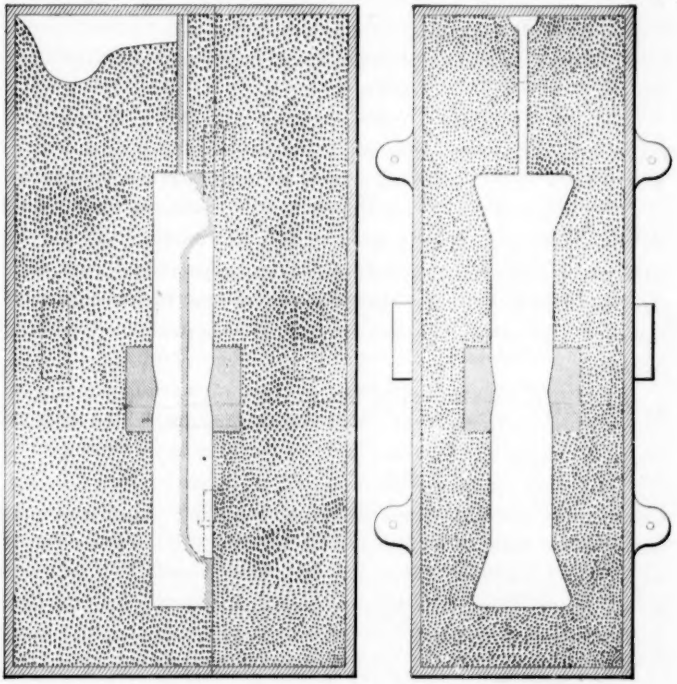


FIG. 2.

by the way broke at one-third of its length from the end. This would show that the slower cooling of the metal in the heavier bar retarded the chilling of the contracted portion somewhat, resulting in less marked contrast between skin and interior.

Now as I believe in having the thickness of the test bar comparable with the thickness of the casting, and as a 2″ specimen

would seem the limit of capacity of our large foundry testing machines, I would suggest that at least three sizes—say 1 inch, 1½ inch and 2 inch—be selected, whether round, square, or both, as a committee may determine. In the plan I suggest for consideration you will notice that all shapes and sizes can be used, and where castings over 2 inches thick are to be represented, a 2¼ inch round bar with a ¼ inch groove turned into it will, by the removal of the skin, give a fair representation of such heavy work whether the castings are to be machined or not.

One last point. Not every foundry is prepared or willing to make dry sand molds, especially when a quantity of them are required daily. Fig. 2 shows a section through a green sand mold, in which you will notice that the effect of the dry sand is obtained by having the contracted area in a core. Not only is there the advantage of making these cores perfect in shape and without parting lines, but also the fact that they can be kept in stock gives us the means of obtaining the required effect quickly and without trouble.

I feel that I have dipped but lightly into an intricate and at times aggravating subject. When one has made some 60,000 physical tests in the last six years, and realizes that, although the test bars were made as representative of the material as possible, there can be no real comparison with the work of others in the same line of foundry business, there need be little wonder why I have tried your patience to-day in urging quick and practical action by the American Foundrymen's Association on this important but still so unsettled question.

The Chairman: The paper is now before you for discussion.

Mr. Gates: How would it do to take core sand and make the core with a proper sized opening and hold it in that?

Dr. Moldenke: That is true enough.

Mr. Gates: Did you find a difference in that, green over the dry sand?

Dr. Moldenke: I mentioned that I finished some experiments just before I came here and made this as a suggestion that it could be looked into further. Any suggestions you can give

me I shall be glad to have tried. We cast some 72 test bars every day.

Mr. West: The point which the doctor makes of having a core to encircle a green sand mold at the point of the bar's fracture is, I believe, to be credited as original. I do not know of anyone having suggested such a method. The plan he has suggested to us is simple and practicable. Casting test bars in green sand molds can readily cause erratic results. Engineers are often puzzled by such tests. They will cast two bars from the same ladle and find the greatest of variations in the records obtained. This is often due to the chilling tendency of a green sand mold, which leaves the carbon in a more erratic combined form than is possible to bars cast in dry sand. This is shown in another part of the paper where, in speaking of tensile strengths, he says he finds greater uniformity by using a contracted bar cast in dry sand than where such forms of bars are cast in green sand. Again, the core is sure to assist in guarding against erratic records as tests due to difference in the temperature or fluidity of metal. Of course the green sand mold as used in general foundries is convenient, and foundrymen as a rule do not labor to get a nicety in that kind of work and take approximate results which in some lines of work answer fairly well. At the present day we are standing badly in need of a standard, something reliable, something whereby if we make tests in our own shops or take tests made in the shop of somebody else, we can make comparisons and find out the true difference of metals the world over. The points the doctor brings out for work, in connection with the International Society, I think is very important, and if there is any society which should take an interest in that work, it is the American Foundrymen's Association. I would like to see a committee appointed here to carry forward such a work.

The Chairman: The subject is of greater importance than you realize. The time is coming very rapidly when you will be expected to furnish castings 25,000, 28,000 or 35,000 pounds' tensile resistance. It may occur that for a given mixture you make a test bar $\frac{1}{2}''$ square. You get about 26,000 pounds in that small

bar. You go on and make the casting. The inspector comes along and makes a test bar 1½", which only gives 18,000 pounds resistance, and you find your labor lost. You review the circumstances and find that the difference of opinion as to size of test bars means dollars and cents, and hence the importance of some standard which will guide us. If this Association adopts a standard, it will no doubt be recognized as authorative.

Dr. Moldenke: I forgot to read one paragraph which suggests different sizes. The only thing I can see in the system which is weak, is that of the casting temperature. I know of no way to fix that. Iron cast hot into a green sand test bar is stronger than when cast thus in dry sand. That is owing to the sending of some of the carbon into the combined state. There are some points we cannot change, but if we can wipe out as many of the disturbing factors as possible the improvement would be great. This style of test bar is a suggestion. That style of bar can readily be taken out of the sand and put into the testing machine, without finishing at all, if desired. I have cast some bars with those sloping ends, put them in the clamps arranged with ball and ratchet, and pulled them and the alignment was central every time. If you want to machine your castings it would be well to take the skin off the point of contraction only. If you have castings heavier than 2", then cast the heaviest bar you can for your machine and turn down the section ¼" at one spot, and you get an interior that corresponds with that of heavy castings. One universal bar will not do, for every condition which might arise you must have something to meet it. If we can get a system of testing cast iron that is good our European friends will probably adopt it. I should like to see foundrymen protect themselves against what is coming. We are all going to work to specifications some day and if we can say, "here is a standard system which is as nearly correct as possible," others will come and adopt it also. But if they make standards for us we shall have ten or twelve different kinds to meet.

The Chairman: The gist of the paper is in the recommendations made and is before the Association in a direct form (here

reading 1). That is the matter before us now. What shall we do with it?

Mr. Knight: Regarding Dr. Moldenke's suggestion, I wish to say that in probably three-fourths of all the contracts drawn up, the one test specified is the tensile test. In speaking of the reliability of tensile tests for cast iron, I would say that I have seen a bar cast 1" in diameter and machined down to half square inch broken at 17,000 pounds, while a bar cast from the same gate, but 1½" in diameter, machined down to 1 square inch area broke on the same machine at 34,20 pounds. This is a variation of but 200 pounds and while such regularity is exceptional, it is not wholly unknown.

In regard to transverse tests, we now make a bar which has proved itself to be pretty generally satisfactory; out of fifty bars broken, probably one breaks at a flaw. The bar used measures .794" and is broken on twelve-inch bearings. One of these bars I have with me this afternoon and shows that the chill on the edge is so slight that it is hardly perceptible. The microscope will, however, clearly reveal its effect. The variation in breaking strain on four of these bars cast on the same gate will usually be less than 50 pounds. This, I think, would be regarded in practice as rather uniform; more so, I should judge, than the 1"x2"x24" bar so popular for transverse tests.

Dr. Moldenke: I would say that if you show that bar to the Pennsylvania Railroad, they would not adopt it, for they use a 2" bar square. There is something I recommend which requires practically no machine work on it, and a machining costs money. We want something as cheaply and easily made as possible. If the committee is appointed they will, of course, take that into consideration.

Mr. Knight: I would like to ask why the Pennsylvania Railroad Company would not accept this bar, provided that they knew it was going to give satisfactory results. I have here one of our blanks showing the results on two of these bars, both from the same gate. One broke at 1,425 pounds and the other at 1,465.

Dr. Moldenke: I have seldom been able to obtain anything nearer than 200 pounds; a ten-pound difference is phenomenal. A bar like that would represent only a casting of about the same thickness. I would not trust a small bar to represent a very thick casting. Your bars should represent as nearly as possible what is the thickness of the work. I use daily ½" by 1" and 1" by 1" in my work and expect to use these sections until the committee or others tell me of something better. Still, I am satisfied that I am only getting the weakest spot in that bar, instead of a true valuation of the metal.

Mr. West: Mr. Knight calls our attention to the fact that the carbon is more combined in the corners of square test bars than on their surface. We know that the quality of combining the carbon is to harden the casting or iron. To harden the iron is to give it greater contraction. We are getting in a square bar or those of that character three or four different grades of iron. We can affect those different grades by variation in the temperature of the sand and fluidity of the metal with which we pour it. It is not new to members here to know my position on the test bar question or that I advocate bars larger than ½" square or round. I do not care to go into a full discussion of the subject here to relate what I have said before, but I hope a committee will be appointed to advance this work and have all data presented in a manner that the best results and the truth will be presented for the use and consideration of all. As to the idea of having a test bar show us what our castings are, is a mistaken idea. A test bar can only be used for a comparative measure in testing mixtures or the strength of sections. In most every shop we have, it might be said, a hundred different castings; they may be fairly uniform in thickness, but the difference which exists in temperature and fluidity of the iron and variation in the "temper" of the sand makes the comparative value to be obtained from test bars very indefinite in affirming what we may truly expect from any casting owing to the weakening effect of coal-shuts, sand or blow-holes, etc., which all castings can, to a greater or less degree, contain. Then again, a casting may be solid as

a dollar but possess internal contractions, strain due to parts not being in proportion to each other, that would annul the value of test bars to define a castings' strength. In reality, to learn the actual strength of a casting, it is often necessary to subject it to strains, blows, or actual usage.

Mr. Bauer: We have here one of our daily reports which we use and which represents the iron we get. Our test bar is .794-inch square, and represents the usual or average thickness of the castings which we make. We have not taken the one-inch bar or the half-inch bar, because we do not consider either one represents our castings as perfectly as does this .794-inch, the breaking strain of which is theoretically half the breaking strain of a one-inch bar on twelve-inch bearings. These bars we pour in pairs at different parts of the heat. Here is our record for June 4th: Eight bars in four pairs. Pair one broke at 1,455 and 1,465 lbs.; pair two, 1,425 and 1,440 lbs. These were cast about an hour apart, but in the first part of the heat. Pair three, representing a change in the mixture, after pouring one-half of the heat, broke at 1,555 and 1,545 lbs., and pair four at 1,605 and 1,550 lbs. In regard to chilling iron and making it harder, I wish to relate our experience with our regular test bars. Our test bar being cast in a yoke, both ends of the bar run against chilled surfaces. We have drilled our holes for testing the hardness of these bars at different points, and found a variation of hardness in the same bar. We find the hardest part is at the gate, and the softest part is at the nearest point we can drill to the chilled end.

Mr. Switzer: While this paper is interesting, to bring this matter before the convention, I move that a committee be appointed to go into the question and report at our next meeting.

Motion duly seconded, put and carried.

The Chairman: The next point is the advisability of joining the International Association. I think that should be done without further comment; we should become associated with the International Committee. The American Engineers are members, Civil Engineers, etc. That hardly requires formal

action on the part of the Association. The secretary will be authorized to make application for membership. If there is no objection it is so ordered. We are now to hear the report of the committee of the Pittsburg Association on Standard Methods of Making Chemical Analyses. We are ready to hear from your commimttee, Dr. Moldenke. The local association has taken this matter up, considerable work has been done, and it is before us in a practical form.

Dr. Moldenke: This is a memorial presented to the American Foundrymen's Association:

MEMORIAL PRESENTED
TO THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

The undersigned, a commmittee appointed by the Pittsburg Foundrymen's Association, do respectfully memorialize the American Foundrymen's Association in convention, in behalf of a project to establish a central agency for the preparation and distribution of standardized drillings of cast iron.

Ever since scientific methods of analysis have reached a point when their application to daily practice has become of manifest utility, the need has been felt by those most interested of positive assurance as to the reliability of the complicated processes and delicate manipulations upon which so much is made to depend.

The series of comparative analyses recently made by twenty practicing chemists shows very strikingly that the uncertainty complained of is well founded. Managers and chemists have been interchanging samples for mutual examination for a long time, and indeed, the whole system of instruction in our universities and schools is based upon standardized samples prepared by the professors in charge.

A point seems to have been reached when our foundrymen, who are just beginning to give close attention to the practical aspects of chemical work, should be protected from annoyances and losses due to errors which might have been avoided.

Incidentally this committee cordially indorses the recent appeal issued by Dr. Colby advocating stricter and better methods of sampling at the furnace, and hopes that the question will re-

ceive proper attention in due course. At the same time this committee feels that the first step should be in the direction of affording facilities to foundrymen, blast furnace managers, metallurgists and chemists, to obtain correct results from samples standardized by the best talent of the land.

To carry out this idea properly, this committee respectfully recommends to the American Foundrymen's Association the endorsement of a plan, as outlined below, to establish a central agency for the preparation and distribution of standardized drillings of cast iron.

From preliminary work carried out with a view of placing such an agency on as high a plane as possible, and at the same time to make it self-supporting, it can be reported that the kind offer of Professors Benjamin and Smith, of the Case School of Applied Science, to supervise the details of the work, is at once a guarantee for the reliability and excellence of the material to be sent out. Furthermore, the number of preliminary orders for such standardized samples already received in the few days that public attention has been directed to this matter, leaves no doubt as to the financial success of the undertaking.

Once a sufficient number of orders are at hand the work could be begun, and conducted on the lines of the greatest good in this direction for both foundry and furnace.

Finally, should the American Foundrymen's Association endorse the project, we would respectfully recommend the appointment of a committee of seven members, who are to report at the next meeting.

This committee should work through three sub-committees chosen from their number, as follows:

A sub-committee on Finance.

A sub-committee on Publicity and Promotion.

A sub-committee on Methods and Results.

All of which is respectfully submitted.

THOS. D. WEST,
ISAAC W. FRANK,
RICHARD G. MOLDENKE.

The Chairman: You have heard the memorial. The matter is before you for action. In short, it means that the influence of the Association be asserted by adopting the recommendation. A resolution will be in order accepting this memorial and authorizing the appointment of a committee.

Mr. Seaman: I will offer a motion of that kind in the matter.

Motion duly seconded, put, and carried.

Secretary Penton then read a paper by Chas. Vickers, entitled, "A Talk on Brass Founding."

A TALK ON BRASS FOUNDING.

By CHAS. VICKERS.

Brass founding, like most other trades, naturally divides itself into classes. One foundry makes a specialty of plumbing goods, another of chandelier fittings, while another will devote itself to making machinery castings generally.

Plumbing goods comprise, as the name signifies, all brass goods used by plumbers, such as faucets, waste cocks, ferrules, etc.

Yellow brass is the metal generally used, and the work is of such a character that the patterns can be carded, namely, attached to match plates or boards, or else "gated," that is, a sufficient number of patterns to fill the standard size of flask, are riveted or soldered to the gate, practically forming one pattern. Both "plate work" and "gate work" have their own individual spheres of usefulness, but the writer believes, from his own experience, that it is better to put the patterns on plates in preference to gating them, whenever it is possible to do so. Bibs and cocks with their component parts, such as plugs, handles, stems, etc., and globe and other valves the parting lines of which are straight can be all made by the match plate system, thereby saving the time that would be expended in making matches, trimming the joint of the mold, etc., as is necessary with gated patterns.

In order to turn out this class of work to the best advantage, first-class flasks should be provided and kept in good condition. Interchangeable flasks are almost a necessity on plate work, as the plate must fit on the pin halves of flasks, which are used as nowels.

A yellow brass called dipping metal is generally used for chandelier castings. This class of work is mostly light and ornamental in character. Much of this work is skin dried by spraying with gasoline and then burning off.

There is quite a knack in pouring, as the metal must be thrown into the mold with force enough to run, and at the same time not strain the casting.

No branch of the foundry business calls for more individual skill on the part of the molder than that of machinery brass work.

Not only must the workman be equally at home on floor or bench, but he must be prepared to turn out castings in a dozen different alloys, each of which has its own peculiarities in changing from the liquid to the solid state, which peculiarities must be humored in the construction of the mold, or trouble will ensue.

Some alloys, as for example phosphor bronze, require the mold to be rammed more than ordinarily firm, while in the case of aluminum bronze we must go to the other extreme and ram it exceedingly soft, so that the mold will not resist the excessive contraction, otherwise the casting will be drawn apart.

Phosphor bronze shrinks but little, but if poured too hot it will eat into a green sand mold almost like water; to prevent this it is poured cool into such molds. It can, however, be poured hot, provided the mold is well coated with plumbago, and then baked before casting.

Chain guards for ladies' bicycles are a class of work that sometimes cause a great deal of trouble. They are made of aluminum and the trouble is caused by their cracking. After repeated trials, one firm with which the writer is acquainted, made them successfully by soft ramming, gating them with two broad, thin gates on the sprocket wheel end, and elevating the sprue end six inches.

The metal was thrown in at a dark red temperature, and immediately the copes were thrown off, while the metal in the sprues was yet liquid.

On small, loose jobbing work, when there is more than a dozen pieces required, it will pay to make "set" gates, as they save the time consumed in cutting and slicking the gates, besides producing cleaner castings. They are easily made as follows: Make a mold, cut the gate as required, leave the patterns in, close the cope and pour into the gate cavity tin at a low temperature so as not to injure the patterns if they are wood. Should there be any castings previously made from these patterns, draw the

patterns and substitute the castings, before closing and pouring the mold.

In making heavy brass work it is advisable, whenever the shape of the pattern will permit, to pour from the bottom exclusively. Take for instance a brass bushing weighing, say, over 500 pounds. Suppose the pattern is 18 inches in depth, three or four feet in diameter and anywhere from 1½ to 2 inches in thickness and has a green sand core in the center. The casting had better be poured with two pots, and gate at the bottom through runner cores. When the metal will impinge on the green sand core, a piece of dry core is built in to prevent scabbing. The runner which leads the metal from the joint to the bottom of the mold should be about one inch in diameter. From the joint up, through the cope, it is enlarged to between two and three inches in diameter, thus we get metal to feed, and keep the gate solid. A so-called skim gate is used in pouring. About four inches distant from the aforesaid runner with its riser, another runner cuts through the cope, to the joint; it is connected to the riser of the first runner by a horizontal channel cut in the cope. This channel must taper from the runner, to the riser, like a nozzle. It is comparatively small at the junction with riser.

Here is the point where care and judgment must be used. If it is too large it will take the metal too fast, making it impossible to keep the pouring head full, and the scum will enter the casting, showing up as dirt. If it is too small it will not take metal fast enough, and the casting may not run, as it is poured rather cool. When pouring, as the pots empty the stream naturally grows smaller, this is another point to be watched or the head may sink, and the whole of the bubbly scum be sucked into the mold. When the head is successfully kept full, this method of gating gives clean castings.

In order to feed and prevent shrinking in the casting we have been considering it is prudent to put on a riser 3½ inches in diameter. It must not be put on top of the casting but about an inch away from it anywhere where convenient, connected with the casting by a good deep gate, filleted so as to break off hot,

without breaking in. Carry the feeder up four inches above the cope. When the mold is filled, cover the pouring head and top of runner riser with sand, bed on a weight then fill up the feeder head. Shake out while hot, break off feeder and runners, and scrub the casting with a spade.

As the making of alloys of copper is a subject that has been ably and extensively dealt with by writers, and before this association, it would be only repetition to mention the same here, further than to remark, that it is very seldom that the practical metal mixer gets a chance to use wholly new materials. The scrap brass must be used up somewhere, and it is generally cheaper than a new mixture. To use it judiciously is where the art of metal mixing comes in. The mixer must be able to judge of the quality of the metal in the different pieces of scrap as he sorts them out.

Bells, bearing brasses and bushings are, as all practical men know, generally hard brass. Car brasses justly come under suspicion, they are often made of old copper buttons and scrap containing iron. They must be used sparingly in finished work. Valves and small red brass scrap are generally soft, and may be used accordingly. Soft brass may be stiffened by the addition of hard scrap, and porosity guarded against by adding yellow brass scrap.

Scrap metal has a great tendency to make dirty castings; guard against this by cleaning the metal before pouring. Bring the metal from the furnace hot, add the new metal mixture. After stirring thoroughly scrape down the sides and bottom of the pot, inside, with the skimmer, which had better be of ⅝-in. round iron; stir again and skim off. If the metal is hot enough, there may be time to repeat the stirring and skimming. A surprising quantity of dirt is removed from the metal in this way. When pouring, bridge the lip of pot with the skimmer, holding back all dirt. The writer has made key heads, scaling 30 lbs. each, with only 1-16 in. stock allowed on both sides for finishing, out of common scrap by using care as aforesaid, and not lost one out of sixty.

There was no discussion.

The Chairman: The next paper is one by C. A. Bauer, on "A Test for Determining the Hardness of Cast Iron." Mr. Bauer, Jr., who is present, requests me to state that the paper is written by his father, and in the absence of that gentlemman his son will read it.

A TEST FOR DETERMINING THE HARDNESS OF CAST IRON.

By CHAS A. BAUER.

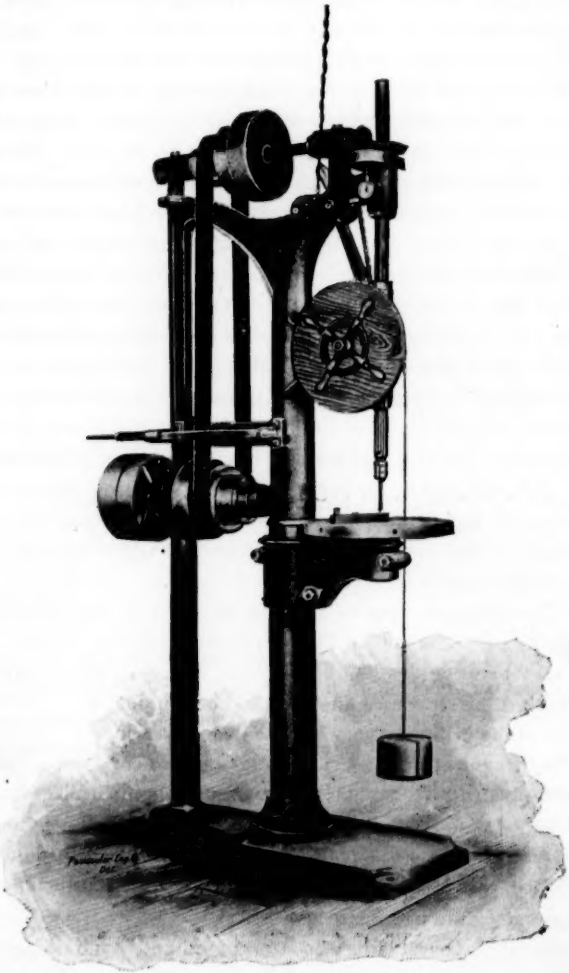
Inasmuch as none of the previously known methods for determining the hardness of cast iron had proven to be practical for a number of reasons, foremost among which was the impossibility of duplicating the results obtained, which was sufficient in itself to demonstrate that the method in question was unsatisfactory in character, it became imperative that some method be devised that would be simple and yet reliable, and which would contain none of the objectionable features which are known to exist in other methods.

As the previously mentioned tests were merely superficial, dealing solely with the character of the surface of the metal, which is no indicator of the nature of the material beneath it, we can readily see at what a loss any manager must be who depends upon such tests to control the hardness of his castings. Since the everyday use of these tests was impractical, the physical characteristics of the foundry product was determined by inquiries directed to the heads of the different departments where machine work was done. The results obtained in this way being conflicting, and in many cases contradictory, made it necessary to inculcate into the new method mechanism which was absolutely automatic, in order to eliminate any possibility of personal equation entering into and affecting the results of the tests.

From the fact that a drill running at a uniform rate of speed and under a constant pressure, the number of revolutions which would be required to drill a given depth would be directly proportionate to the hardness of the material being tested, it was deemed expedient to formulate a method along these lines.

An ordinary drill press was equipped as follows: On the pinion shaft, which raises and lowers the spindle, is attached a disc twelve inches in diameter, around the periphery of which is placed a light flexible wire cable, on the end of which is suspended a weight which maintains a constant pressure upon the drill.

The standard drill is now placed in the chuck. The drill spindle has a revolution counter, and by means of magnets and an arma-



MR. C. A. BAUER'S APPARATUS FOR DETERMINING THE HARDNESS OF CAST IRON.

ture is controlled by the position of the drill in relation to the table. All adjustments are made so that the revolution counter is thrown into gear after the point of the drill is entirely embedded under the surface of the test piece, and out of gear when the spindle has descended from this point exactly one-half inch.

When the test is to be made the test bar is placed upon the table and the drill is brought down upon its surface; the feed lever is then unlatched and everything is ready for the test. The drill is now rotated at a speed of 250 revolutions per minute, and the hole drilled. The revolution counter is electrically thrown into gear after the drill point is buried beneath the surface, and out of gear when the one-half inch from this point has been reached. The reading of the revolution counter now gives us the exact number of revolutions required to drill the one-half inch, and this we term the degrees of hardness. The more revolutions required the harder the casting; slight variations in hardness being easily detected.

We have adopted, and would recommend as a standard, a $\frac{3}{8}$ in. flat drill having an angle between its cutting edges of 120 degrees and a clearance angle of 10 degrees, running at a speed of about 250 revolutions per minute and having a constant pressure of 160 pounds.

A flat drill has been adopted on account of the facility with which it can be ground to the proper angles. The cutting angle may vary between 115 degrees and 125 degrees without affecting results, but the clearance angle should be ten degrees. The revolutions of the drill may vary between 240 and 260.

The pressure on the drill should be as near 160 pounds as possible in order to compare with results obtained elsewhere by this method, and should be determined while the drill is in motion. We have placed a small platform scale upon the drill table, then placed the test-piece on this scale and found the pressure to be 160 pounds while making a test.

After the apparatus has been prepared and standardized, it is well to determine the hardness of a long test piece, which should then be put away and preserved as a standard. Any changes

which may then take place can be entirely eliminated and results reduced to the standard by the formula,

$$\text{Degree of hardness} = \frac{Dr}{R},$$

in which D = the degrees of hardness of standard test piece; R = the number of revolutions of drill required to drill that piece under present conditions, and r = the number of revolutions obtained in drilling the piece, the hardness of which we wish to determine.

We make daily tests of our cast iron and mark each piece with its determined degree of hardness, and use any one of them to determine the change in the drill.

We have selected four test bars which represent four grades of hardness. Castings for our purpose should range between that determined for Bars Nos. 2 and 3; No. 1 would be considered too soft, while No. 4 would give us trouble in the machine shop and would surely bring in complaints. We repeated the hardness test on each bar, obtaining three results for each bar. We herewith submit results of these tests:

Bar.	Hardness.		
No. 1	130	128	129
No. 2	150	149	149
No. 3	170	168	167
No. 4	236	232	230

The greatest variation of results occurred in the drilling of the fourth bar, where it was less than three per cent. We therefore believe that we have a reliable test and one that will prove of great practical value to all foundrymen.

The Chairman: You have heard the paper. It is an important matter to be able to determine the hardness of a casting, especially to those who make light castings. The subject is important, and if the method meets the requirements it is an advance.

Mr. West: As far as I have been able to make a study of this machine, and from my knowledge of what exists, I believe it is the best machine we have up to date. The test of hardness at its best is not a very satisfactory one, and comes under the head of

special tests. There are many cases where, if we had something that was perfect and reliable, it could be used to excellent advantage. In a series of tests which I have started at the present time and hope to conclude before long, I believed I could find a machine like that to be very valuable, which in this case is testing the peculiar qualities of hardness that would be derived by aiding hardening of iron by means of manganese or sulphur. There is a dispute at the present day as to the peculiar results of these two elements in hardening the iron. Tests show that some wheel makers prefer a high sulphur iron in car wheels, and some believe that the tread on a car wheel will last longer with iron hardened by sulphur than with manganese, the latter giving a metal more easy of wear. This same question comes up in regard to chilled roll castings. Whether low silicon hardening assisted by means of high sulphur or high manganese is the best for wear, and the question of which of the two elements are best to stop "checking," is one on which we have a good deal of knowledge to yet obtain, and such a machine for this particular class of test should be very valuable.

Mr. Gates: I would like to ask Mr. Bauer whether he begins the test as soon as the drill strikes the scale?

Mr. Bauer: We have adopted this method. It is slightly at variance with the original one we used, which was to take the total number of revolutions required to drill through the bar from the time of starting the drill until it dropped through. By taking half-inch we find we can make comparative tests with pig iron or any material we choose, using only that half-inch or any portion of it; since the drill runs at a uniform rate, one inch would require double the number of revolutions required to drill the ½". We do not take into account the surface of the metal, but bed the drill, and from that point take the ½". We do the testing just as we do the machine work in the shop, and get all that is desired for our purposes. We have been invited and requested to take this method and carry it further with a view of having it generally adopted, so that when one spoke of degrees of hardness we would all know practically what was meant.

Mr. Gates: Do you prepare chilled iron?

Mr. Bauer: We have nothing to do with that. The machine is used on our regular test bars which we cast in yokes. We use it only where we intend to machine the castings. Where the castings are too hard for the machine I would not advise you to use it. We allow for the wear of the drill in this way: We will now make, say a test for hardness; our drill has been properly ground and everything satisfies the requirements. We now drill the bar and obtain its degree of hardness. We always mark the degree of hardness on the bar with a piece of chalk. After making a number of tests we redrill this bar, but find now probably more revolutions are required to drill it, due to the wear of the drill which will no longer satisfy the conditions of a standard drill and must have its constant determined in order that it may be used. We divide the number of revolutions last obtained by the degrees of hardness of the bar; the quotient is the constant for the drill.

The Chairman: The next paper is that by Guy R. Johnson, entitled, "Manganese in Cast Iron." As Mr. Johnson expects to be present a little later, we will defer his paper to to-morrow's session. We will take up Mr. West's paper now.

Mr. West then read his paper, as follows:

NECESSITY OF WELL MIXED FURNACE CASTS AND CORRECT PIG IRON ANALYSES.

By THOS. D. WEST.

The recent advance in founding, causing us to realize that the grain of pig metal is not a reliable index to its grade, has opened a door to such results, through the occasional indifference and error of those using analyses in shipping iron, as may cause more contention than ever between maker and buyer and often heavy losses to both. A few years back every furnace had its "graders" whose special business it was to direct the separating of casts of iron into different piles, according to the grain of the pig metal. The most open pigs went into piles as No. 1 iron; the smaller grained as No. 2, 3 or 4, according as the grain decreased in size. The greatest care was exercised in thus grading iron, not only because all believed that the size of the grain revealed the grade, but also because the "grader" had a reputation to sustain, in making his various piles of even grain and the furnaceman was anxious to have every pig of the open iron collected by itself, for a No. 1 iron brought him more money than a No. 2.

With the advent of selling by chemical analyses, all this was changed. The graders were replaced by the chemists and the iron as it came from a "cast" is now thrown into one pile, and neither furnaceman nor progressive founder, as a rule, pay any attention to the size of the grain in pig metal. Yet, entire reliance upon analyses sometimes leaves the purchaser, it might be said, in the position of the man buying a "pig in a poke," because the reported analyses may belie the real composition of the iron. Because of this fact, any indifference or error on the part of the shipper, might cause grievous injury as well as losses to the trade of both furnaceman and founder, especially to founders who do not employ chemists to check up their furnace analyses. It is not the purpose of this paper to indicate in detail how errors in reported analyses can be made. Furnacemen

know this themselves. The main object is to urge that furnacemen use every precaution to have reported analyses as nearly correct as it is possible to have them, and to have the various "casts" at the furnace well mixed. It should not be inferred from what is said above that all furnacemen are indifferent to their analyses reports. Some are striving earnestly to avoid mistakes in this particular. But I can say, that our firm has had such losses from want of care on the part of some furnaces, in the matter of reporting analyses, that we will not wholly depend any more on furnace analyses. We now have our own chemist, who "checks" every car of iron that comes into our yard. Since we have adopted this measure, it is rare (providing a car or cast of iron is fairly uniform), that we vary .10 in silicon or are seriously off in the sulphur desired in our product. Before we had our own chemist we were as liable to be .75 off in silicon or .04 in sulphur as we were to obtain the desired results, let the car of iron be ever so well mixed or uniform in grade. I am well aware that furnacemen could reply to this paper by citing cases wherein failure to obtain desired results was due more to the ignorance of the founder than to errors on the part of the iron shippers. This I do not deny; but there should be an end of tolerating such ignorance on the part of the founder. As the buyer, he should tell what he wants as is the practice in purchasing most stable trade articles. If a founder is unable to specify for himself what class of iron he should have, or the combination of elements necessary to give him desired physical results in his casting, he should suffer his own losses, till he learns. There is no excuse at this day for his not knowing all this, at least, as much as he has any right to expect of the furnaceman. It is not just that a furnaceman should assume the responsibility of what a founder may obtain from a mixture of his iron, for the founder can readily nullify the value of analyses, or the results to be obtained from pig metal in mixture by itself, by the use of scrap or by variations in fuel and methods of charging. All that should be expected of the furnaceman is a well mixed "cast" with a correct analyses of the iron. But to secure

this, much reformatory work is yet to be done. The aim should be to discover, if possible, what factors are constant, impractical of change, and those that are influenced by judgment or care of the operator. There are many chances to make errors in the analyses cards of iron from the time it leaves the casting house until it reaches the cars ready for shipment. Such work may have to pass through the hands of four or more men by whose carelessness the reported analyses may be badly distorted from that found by the chemist. My reasons for arguing every founder to employ his own chemist are two-fold. In the first place, this plan better insures desired results from mixtures; in the second place, the control of operations by analyses, would soon be so perfect that foundrymen unaccustomed to employing it, would be compelled to recognize their progressive competitors' advantage, in securing and holding trade and would follow their example. It is not to be expected that all founders knowing the advantage of working by analyses will advocate its general adoption. There are many to-day working by analyses who would prefer not to have its use extended, simply because they are satisfied to make the money, if their competitors are satisfied to plod along without being able to declare dividends.

In one sense blast furnacemen are not to blame if they are indifferent to exactness in analyses, for the founders utilizing chemistry are in the minority at the present day. The majority are indifferent or prejudiced against chemistry. Then again, we have those whose self interests lies in advocating old practices and who, taking advantage of the majority's indifference, can decry the adoption of analyses. Their action is inimical to the advancement of founding, as is that of the politician, who, to gain office, will cater to ignorance for the purpose of catching votes.

But granting that the furnaceman has not at present every incentive to accuracy, how are we to expect foundrymen starting out to test the utility of analyses, to become its advocate, if his furnace report turns out to be incorrect? Is it not natural for such a founder to declare working by analyses unreliable, or not as good

as judging pig iron by its fracture? All those who know working by chemical analyses to be the better way, when correctly applied, should labor earnestly to assist in bringing the whole foundry world to recognize its merit. When this comes about, no furnaceman will think of going out to his yard to select an open iron and mark it high in silicon, when he knows that the analysis shows it to be low. Nor would one continue shipping car after car from piles which he knew that through mistakes in keeping track of them, the office had got so badly mixed that only by reanalysis could it be learned what each pile was. Further, the furnaceman would be careful not to allow different "casts" to get so badly mixed up in one pile that when the founder received the car of iron he would find, should he check the furnace analysis, that part of it would not run much more than .50, while the other might run to 2.00 in silicon. The writer's firm has been the victim of just such indifferent and careless work, which illustrates what trouble may come to a founder working to analyses, but having no chemist to check up the furnace report, if shippers of iron are not careful and conscientious in their work.

Furnaces should recommend the use of chemistry to all founders, and to employ their own chemist if possible, since it will lessen contention and bring their business to a much more satisfactory basis. Before we had our own chemist, hardly a week passed without some furnaceman arranging for trouble or loss which his iron was causing. Since we have had our own chemist, we have had no occasion to interview the furnaceman (barring the question of well mixed "casts") other than to purchase his irons. Where is the founder having no chemist, or making his mixtures by judging fractures, who can say this?

UNIFORM CASTS OF PIG METAL.

The second need that may properly be discussed in this connection is uniform casts of pig iron. These may be so irregular at times as to make one end of a "cast" only suitable for making chilled castings, while the other end might be soft enough for

light machinery or stove plate work, and yet all the iron might be reported under one analysis. This subject has been discussed by the writer and others in previous articles, but as it has an important bearing on the movement for "greater uniformity in the analysis of pig irons," I have here, as will be found, extended the subject in presenting new thought and experiences necessary to be added to what has previously been written to show the necessity of reform in this direction. A committee, of which I have the honor to be a member, is to bring this matter in its relation to uniform analyses before this convention for its sanction and co-operation. Nearly every car of pig iron illustrates in greater or less degree the evil of non-uniformity in furnace casts. I have seen, for an example, a car of which one sampling showed 2.00 in silicon, another 1.30 and a third .70. Much trouble and actual loss might result from accepting any one of these samplings as representatives. Could this evil be overcome, the experienced founder, having his own chemist, might go along for months at a time without experiencing any difficulty in obtaining to a nicety any physical qualities he had figured for his mixture, providing, of course, that the founder's chemist keeps a close tab on the sulphur contained in his fuel. The point made above applies more directly to the founder having but one mixture of iron to take out of his cupola at one "heat," and who from necessity must use his irons from the car or a small yard. Where founders have two or more mixtures to bring out of a cupola at one "heat" there is, of course, the liability of each affecting to a greater or less degree the other's qualities; but this is a question apart from that treated by this paper and is dependent upon the founder's experience and care in charging his iron. In sampling a car at the present day no less than five pigs should be selected, and these should be chosen from equal divisions from a car or cast of iron. In cases where the best care is desirable, it is sometimes well to make two sets of analyses, taking four pigs from each end, so as to divide the car in two sections, which should be separated to make dis-

tinct piles in the yard or on the cupola staging, when the various percentages of silicon, etc., in the different piles can be figured, to indicate just how much of each pile should be taken for the average desired.

Dr. Richard Moldenke gives an interesting article in THE FOUNDRY of January, 1898, describing a plan that may sometime be adopted to secure a better mixed iron, than if it had been taken direct from the car for use in the cupola. It is to have all carloads of like reported grades piled one on top of the other and to draw from their ends to make up the charge, one analysis being made to answer for the whole pile. Drillings are taken of several pigs selected from each car and at the end all the different cars' samplings are mixed thoroughly together in one sample, which is then analyzed. Two entire trainloads of iron have been successfully piled and used after this manner with only one analysis for the whole lot. Where yard room is plenty or where one grade or mixture of iron is desired, such a system may often answer. Many founders are not situated so as to adopt this plan. They must use their iron to make several mixtures at one heat, or are limited for yard room, so as to be compelled to take their metal direct from the car. The best plan for the latter class seems to be that of taking the car analysis by the sampling system herein advised. Furnacemen by furnishing well mixed casts of their iron could assist such founders, as then no matter how many samplings might be taken from a car of pig metal, no two would be found to vary materially in analysis. It strikes the writer that any furnaceman who would work to this end and prove to his customers by actual tests in sampling, that each car of his iron will run uniform, would have no difficulty in placing his iron, and in many cases at a price that would exceed that of iron furnished by those treating this subject with indifference. It is certainly worth something to the general run of founders, especially those who must use their iron direct from cars or small piles, to be assured that the one analysis of any car of iron coming to their yards will correctly represent both ends or any section of it which might be taken for a

mixture. I believe that a few furnacemen have adopted the plan of dividing their "casts" in two parts and analyzing each section so as to give the purchaser several analyses of the one cast of iron. Such efforts are to be encouraged. There are several methods that could be adopted which the writer has in mind, but will not take space to outline, as any furnaceman who has an interest in furnishing well mixed casts can with a little study easily adopt or devise ways of doing so. Give the experienced founder a well mixed cast of iron and a correct report of its analysis, with a knowledge of the sulphur in his fuel, and it should be rare indeed for anything to occur to prevent his attaining to a nicety, day in and day out, the exact physical qualities desired in his casting, especially where one mixture is used throughout a "heat." Certainly our American Foundrymen's Association will have earned the gratitude of all makers and users of foundry irons, if it shall take steps to secure the practical realization of the end sought to be advanced by this discussion.

Mr. Bond: How do you take your samples of borings from the pigs?

Mr. West: In checking up our furnace analyses our iron comes to us broken in two. We go over a car and take what we consider five fair samples, two from each end and one from the middle of the car. We take the half pigs and break them, and then drill into the ends of the pigs as near to the center as we can get. We use a $\frac{1}{2}''$ drill and take the drillings obtained from the specimens to the laboratory for analysis.

Mr. Bond: We found at one time that the analyses made by our chemist were differing very widely from the analyses of the same iron as furnished by the furnace. Inquiry from the furnace as to how their samples were obtained brought from them the statement that their chemist procured his samples by chipping off a small piece from the side of one pig and then pulverizing it with all the sand and dirt that was adhering thereto. We considered that this explanation showed us conclusively that the

cause of their analyses differing from our own was the faulty manner of preparing their samples.

Dr. Moldenke: I take 10 pigs from a carload, and I have my assistants drill them in the center of the fracture. There is, of course, a difference between the outside and inside of pigs, but the silicon is really the whole business, and there is little difference in that. I would not trust the furnace analyses altogether. In the analysis Mr. West made he bored into the pig, too, but was careful to remove the sand from the outside.

Mr. Bauer: Regarding taking samples from the end of pigs, we have learned that it depends where you drill that pig. We find that the sulphur varies sometimes considerably between bottom, top and middle of pig. We also find the hardness varies materially in the different portions of the ends of those pigs, and some uniform or regular method for obtaining these drillings would be an advisable thing to consider.

Mr. Frank: At a meeting of the Pittsburg Foundrymen's Association, held a short time since, Mr. West's paper on "Standard Analysis" was discussed; also, the subject of sampling. There seems to be a wide difference how this sampling should be done. Mr. James Scott, superintendent of the Lucy Furnaces, described their method of sampling. They use what is known as a casting machine instead of the pig bed. The molds of this machine are served by a ladle, which holds the entire "tap" of the furnace, 40 to 50 tons. When this ladle is about half run out, a molten sample is taken, dropped into a bucket of water, producing chilled shot; these are then put through a four-mesh sieve; from these shots they make analysis for carbon, silicon, phosphorus, and sulphur. You can readily conceive that this sample, free from segrigation, would, and does represent much more closely the true analysis of that iron than would be by drilling from any number of pigs, and particularly silicon and carbon. It appears to me that this practice might be repeated to great advantage in the foundry. Say, take a half-dozen pigs from a car, these broken, a part of each taken and melted in a crucible, "shotted" in water,

and the analysis made from that sample. The change of elements, due to melting in the crucible, would be slight and almost constant, but will closely represent the car of iron. The danger of getting into the analysis a grain or two of sand , the loss of the fine graphitic carbon, the uncertainty due to segregation in the pig, and the numerous other troubles due to drilling would be avoided.

The Chairman: In accordance with the resolutions passed this afternoon, I announce the appointment of committees as follows:

Committee on Project to Establish a Central Agency for Preparation of Standardized Drillings—Thomas D. West, Dr. R. G. G. Moldenke and J. Scott.

Committee on Nominations—New England, F. H. Colvin; Philadelphia, James S. Stirling; Pittsburg, Dr. R. G. G. Moldenke; Chicago, Christian J. Wolff; at large, F. M. Bookwalter, Springfield.

Committee on Constitution and By-Laws—New England, G. B. Buckingham; New York, W. H. Switzer; Pittsburg, Wm. Yagle; Chicago, W. A. Jones; at large, J. W. Treat.

Mr. Sercomb: I should like to ask when the nominations will be made?

The Chairman: The order of business is that they be made on the morning of the last day.

The session was ended by a motion to adjourn until Thursday evening.

THE SMOKER.

The entertainment committee provided a couple of hours' informal amusement Wednesday evening in the shape of a smoker. A genuine Missouri meerschaum pipe, together with a two-ounce package of tobacco and a small case of cigars, was handed to each one as he entered the hall, and the way the majority made use of the corn-cobs would cause one to think that they had not all been raised on the sunny side of Easy Street.

After those present had been comfortably grouped through half an hour's general conversation, they were treated to a vaudeville show, consisting of songs, dances, contortion acts, etc. At the conclusion of this feature a luncheon was served and impromptu speeches made by Messrs. Green, Sercomb, Cope and others.

One incident of the evening's entertainment is worth more than passing notice. The laughter provoked by the witticisms of Mr. Sercomb and others had not died away when Mr. Jas. Bowron stepped upon the platform, and complimenting the decorator upon the profusion of American flags in the hall, he touchingly referred to the absence of the colors representing "our brothers across the sea." The "three cheers for Old England" which followed should have been enough to convince anyone that although the two great English-speaking nations are rivals for all that the earth holds, yet if appealed to in the right spirit they are nothing if not brothers. Mr. Bowron's remarks upon the future possible alliance between the two countries and his reference to American achievements in peace and war brought such a liberal applause that the speaker must have felt that he had touched upon a popular chord.

THE TRIP TO ADDYSTON.

Accompanied by the Chamber of Commerce band, the foundrymen and their friends left the Grand Hotel at 9 o'clock Thursday morning and boarded the steamer "Island Queen," which had been chartered to carry them to Addyston. Instead of making directly for that place, the steamer carried the visitors up the river for some distance, affording a fine view of Cincinnati and the towns of Newport, Covington and Ludlow across the river.

The thermometer throughout the greatest part of the time during the convention kept hovering at an uncomfortable height, and the refreshments with which the entertainment committee had stocked the boat were patronized and appreciated accord-

ingly. After arriving at the works of the Addyston Pipe & Steel Co., the members scattered throughout the works and inspected the many novel features found in this plant. Returning to the boat, a photograph of the visitors was procured, after which the return trip to the city began. During the homeward journey a fine luncheon was served.

THURSDAY EVENING SESSION.

The meeting was called to order at 8 o'clock.

Mr. Frank: I would like to ask the privilege of the floor to extend an invitation to this Association. Gentlemen, at a meeting held May 23 in the rooms of the Pittsburg Foundrymen's Association, it was resolved that a cordial invitation be tendered to the American Foundrymen's Association to hold their next annual meeting in Pittsburg, and that the presentation of this invitation be effected by me. This invitation is supplemented by an invitation by Mr. Henry P. Ford, Mayor of Pittsburg, and the Pittsburg Chamber of Commerce, through its Secretary, have also written. I should like to supplement these letters by stating that the Pittsburg foundrymen have been the recipients of many favors at Philadelphia, Detroit and here in Cincinnati, and they feel that they should like to have the privilege of returning in a slight degree these favors. It is not possible that Pittsburg can excel or even equal the entertainments enjoyed at other meetings, but I think that city need offer no apologies for asking an association of this kind to meet in their "iron" city. We believe there are attractions there, aside from social amusements, that will interest you all, and we extend to you a hearty invitation.

The Chairman: The proper course in regard to this invitation presented by Mr. Frank, will be to refer it to the Executive Committee for action.

Mr. Newcomb: I should like to move that it be referred to that committee with instructions to bring in a favorable report.

The motion was duly seconded, put, and carried.

The Chairman: The next in order of business will be a paper by Mr. S. S. Knight, on "The Micro Construction of Iron and Steel." But it has been suggested that we take Mr. Putnam's paper in advance, in order not to interfere with the light, which we shall dispense with during the reading of Mr. Knight's paper, that the stereopticon may be used. The next paper, therefore, will be that by Mr. Putnam, on "Inspection of Castings."

Mr. Putnam then read his paper, as follows:

INSPECTION OF CASTINGS.

By E. H. PUTNAM.

When the Secretary some months ago wrote me, requesting that I write a paper for this convention, I agreed thereto, but deferred its preparation till I should be able to judge somewhat as to the amount of literature that would be presented on this occasion. As time progressed it became evident that my effort might have been omitted without its ever being missed. But voluntarily to forego the honor of reading a paper before this association would be an act of self-abnegation that could hardly be expected of me. I have chosen, however, to be very brief, and have therefore taken a topic that can, like Sam Jones, stop anywhere and at any time.

Although the discussion of foundry topics has been wonderfully varied and voluminous during the last few years, yet there is one branch of the business that has received very little attention either in the trade journals or in the papers read before the various foundrymen's associations; and that is the matter of inspection of castings.

In some foundries there is no regular inspection; in others it is practiced superficially, while here and there inspection is rigid, and so employed as to produce the best results, no doubt.

My own experience convinces me that a properly conducted system of inspection is productive of greater benefit than any other branch of management. I repeat, I am convinced that a properly conducted system of inspection is of greater importance than any other feature in management. No doubt, to some this will appear an exaggerated statement or claim. But, much depends upon the meaning attached to the word "inspection." I do not mean by the word, an examination of the castings and rejection of the imperfect before assembling, simply: but something much more definite and effective than this.

The day is past when tolerable castings can satisfy. We are reaching out towards perfection. Of course nobody expects absolute perfection; but a pretty near approach to it is quite practicable and therefore we must have it.

To begin with, the place for the work of inspection should be large enough for the convenient handling of a day's product, and it should have sufficient light to reveal the least imperfection at a glance.

The day's product of castings should be first thoroughly cleaned, and immediately delivered to the inspection-room. Here, each molder's product should be placed in a separate group. Then the inspector should closely examine each and every piece, placing any rejected castings by themselves, and so dispose such as have minor defects as that they may be seen without further handling of the casting. When all the castings have been inspected, the foundry foreman should be called to view them. He will speedily take in the whole matter, and will, in a very few minutes, send for such molders as need correction. He will see to it that each one of these molders examines minutely the defects in his work, and, furthermore, that he knows the cause, and how to remedy it. If the workman himself shall not understand the cause of the difficulty, the foreman must explain it.

All this should be done every day without fail.

My object in inspecting before grinding and chipping is in order to save expense in the latter. For instance, the cores may not fit the prints. If the prints are too large there will be fins to correspond. If too small, a crush, followed by imperfect mending by the workman, will leave an imperfect and unsightly surface. There may be swells, heavy fins, or rough knobs on the castings. If chipping and grinding precedes the inspection, much of this will escape the notice of either inspector or foreman, and so it will go on indefinitely instead of being corrected at the outset as it should be.

The sooner the product is inspected after it is made, the better for all parties. In fact, I think that to-day's product ought to be inspected and exhibited to the molders before to-morrow's molding begins.

I am not much in favor of night work where it is avoidable; but I do believe that it would be highly profitable to clean the whole product of the foundry at night, in many cases, in order

that the molder may know of any shortcomings before he shall have time to repeat them.

In many foundries the castings made to-day will not be cleaned and ready for inspection till noon to-morrow; at which time the molder will have at least two-thirds of his day's work molded up. Consequently, any defects in the castings made to-day will probably appear also in the next day's product. Of course, it is not always practicable—perhaps, it is seldom possible—to clean the castings at night. But, in such cases a great deal can be done to hasten the work that is not now generally practiced. The tumbling mills can be filled immediately following the "heat," and every accessory in order to quick cleaning should be employed. Above all things, the tumbling mill capacity should be ample. There is no reason why, with ample facilities, the whole product of the day should not be ready for inspection, at least by the middle of the forenoon on the following day.

I very well remember a circumstance in which I was both professionally and financially concerned, which transpired just 28 years ago. I was molding sickle shoes, so-called, in a western agricultural works, and, according to the rather lax methods of that day, the castings had been piled up in stock for several months, without having been particularly inspected; and when the assembling began, it was discovered that many of the pieces had a slight swell on the surface over which the sickle ran. My experience was shared by many of the other molders.

Iron molding is a business of such character that eternal vigilance is the price of perfect results. A molder cannot be expected to correct a defect till he knows that it exists. It is therefore of the utmost importance that any defect should be discovered at the earliest possible moment.

In certain classes of castings it is quite practicable to make a fairly good, though not perfect, inspection in the gangway, especially where the castings are cleaned by the steel brush. And in all cases, as thorough an inspection as practicable should be made here, for this will afford an early check upon bad work. And now, unless the molder be shown the defective work, we shall have reaped but comparatively small benefit from the inspection.

It is true that by close inspection we reject bad work, and deduct the price of molding from the workman's pay. But this is only a part of the legitimate fruits of inspection. Fully as important a matter is the prevention of future defective work. The loss of castings is a greater burden to the employer than to the molder even though the molding be not paid for.

For instance, you pay 30 cents for molding, and the casting, if good, will sell for $2. The weight is 100 pounds, and, if the casting is rejected, all that remains to you is 100 pounds of scrap iron, worth, say, 40 cents; add this to 30 cents for molding and we have 70 cents. Deduct these from $2, the price of the casting, and it appears that our loss in a bad casting would be $1.30; while the loss to the molder would be only 30 cents—the price for molding. So that the employer loses four times as much as the workman.

I am aware that it is not customary to figure this matter in this way, but I believe that a close view of the subject will justify my position. From this view-point it is obvious that the employer's interest in preventing loss is much greater than that of the molder. It is therefore important that inspection should follow the molding with as little loss of time as possible.

It is not within the intended scope of this paper to exhaust the topic, and I omit the details of inspection, such as the trying of bolts in bolt-holes, and the employment of templets, etc., etc., my object being merely to emphasize the importance of thorough inspection at as early a moment as possible after the castings are made. In conclusion let me recapitulate

Give ample room, facilities and light in the inspection room.

Inspect as soon after the castings are made as possible, and,

Let the molder see his work, and be sure that he understands the cause of any defects.

The Chairman: You have heard the paper, and it is now before you for discussion. It contains suggestions of vital importance, especially to those gentlemen who superintend foundries, and I know as a fact that there are few founders who insist on that method immediately after the heat, when practica-

ble, to give the men an opportunity to inform themselves as to whether an error was made. My practice has been likewise to take the foreman of the pattern shop along, who would gauge the castings as to shrinkage and contraction, so that correction could be made before the next heat goes on.

Mr. Bell: I believe I agree with Mr. Putnam, in the general propositions which he has made. The first agreement is in the loss of castings by virtue of the molding defects. It is very customary to estimate that loss at a very much lower rate than he has given. I have given the matter a great deal of attention and am satisfied that his determination of that loss is correct, and a much greater sum to the foundryman than to the molder. As to the manner of inspection, I think it is hardly practicable to be carried out as suggested. In all foundries I have had to deal with the matter of cleaning has been part of the industry. It has to be so regulated as to the amount of labor and machine work to be applied to it to fill up the proper time. That is why those castings could not be cleaned and inspected very early the next day. To do the work as quickly as suggested, you would have to multiply the auxiliary men employed, so that you would have to keep them engaged in some other department a part of the time. It is impracticable to clean them at night or early the next morning. A molder is not a machine. I am a molder myself, so I speak by the card. A molder may make a defective casting to-day, and he may be making that piece every day for the next six weeks and the mistake he makes to-day is not necessarily going to follow to-morrow, if he is a good mechanic. So it is not really necessary that he be acquainted by the inspector with the defect the next morning before he makes another piece. If there is a mistake, and he is going to be a loser by it, he is the first to find it out, if he is the right man. At times there are careless men in the trade. It is well enough to keep an eye upon them. While I believe perfect and complete inspection should be had of all work done by apprentices, I do not think it necessary that it be done instantly in order that it should come to the knowledge of the molder that his castings were all right

before he makes them again on the morrow. He is to an extent an intelligent being, and his value is based upon his intelligence. Molding, of all trades I know anything of, is dependent upon the good judgment of the molder, and he knows when he has made bad castings and will use every effort to correct them. If it is the fault of the patterns, he will take steps to have them corrected. I only differ in this, that it is impracticable to have an early adjustment of the matter next morning, and it is not essential to do so, but ultimately it is, in order that the proper remedies may be applied.

Mr. Frank: I both agree with Mr. Putnam and differ and agree with Mr. Bell. The paper treats of castings made on the piece-work system. That foundry is fortunate that can always make castings on the piece-work system. Unfortunately, jobbing foundries and machine foundries working on a great variety of work have not that advantage. Nor have they the advantage of the skilled molders Mr. Bell refers to. Inspection, then, becomes doubly necessary. The fact that the molder is not financially interested in the success of his casting, he being paid by the day, makes it more imperative to look carefully after his work. Mr. Bell says the molder will not make the same mistake one day and the next. But he frequently does; and I know it is our experience that we have had a piece go wrong, due to improper gating, and the molder got it wrong every day for six consecutive days. Unfortunately, the system of inspection was not carried out, and the defect was not discovered for some days. Prompt inspection is very important, and it has been impressed upon me more than ever for jobbing foundries. I believe the recommendation that there should be facilities for inspection, and particularly so in jobbing foundries, is a good one.

Mr. Schumann: I agree with Mr. Bell's criticism as to the impracticability of inspecting earlier than after interval of one day. A day has to be allowed for cleaning castings so that the pattern maker can make measurements. I will mention two instances where such inspection was introduced to advantage. One was in the case of a lighthouse and the other in connection with a series of columns about 28 feet long. The columns were pro-

vided with three sets of lugs between the ends. They were only to be turned at the ends. The specification required that the lugs should not be more than $\frac{1}{8}$ inch at their respective points from end to end. Three of these columns had been watched and found to vary in shrinkage between the lugs and length of columns. Corrections were made and columns were cast of correct dimensions. The other case was in building a lighthouse composed of cast iron flanged segment plates. The first of the castings were all right. In time the molder rammed the flanges out of place and the swelling of the wooden patterns likewise altered the curvature. Daily inspection led to continued revision and correct castings. Without inspection many castings would have been made only to be condemned.

Mr. Best: In making castings 1-16" longer we had a few columns which, when put on the facing machine, gave us nothing to clean up. The next lot that came out were $1\frac{1}{8}$" too long. Whether the iron had been poured too hot, or what was the cause, we did not know. We altered our patterns different times and found the columns to turn out of various lengths, and we could not seem to get the right lengths at all.

Mr. West: Did I understand that there was a variation in the length of the castings, due to contraction? In accepting an order for any large number of castings I always make it a point to insist, if possible, on the making and delivery of one casting first, or to arrange for the party wanting the work to come to our shop to inspect it, so as to see that its design, etc., is all right. Otherwise, you may often closely follow drawings, etc., and mistakes will be made in spite of the most careful attention. Not long ago as an example, I had occasion to make 200 castings (heavy pieces) of which the firm called for one carload for inspection. Well, that meant quite a loss if they were all rejected. Instead of a carload, I made one casting, sent it off with our foreman to the works to call their attention to it. They looked at it in a general way, and said the casting was all right, and we went ahead to make the number required. When they started to use the castings, they found they had made an error in the blue print.

Of course we had their blue print to sustain us, but at the same time there are firms small enough to not acknowledge their castings to be useless on account of mistakes in their own design, etc., if they can possibly find the least defect due to the molding or the metal. For these reasons it is always wise, whenever possible, to give a purchaser a chance to examine or try one casting before going ahead to fill a large order of any one kind. Such a practice will also often prove of as much benefit to the buyer as to the maker of the castings, and is a point under the head of "Inspection of Castings," often worthy of the most serious consideration.

The Chairman: I will answer for Mr. Best. This same thing has happened to most of us, probably, variable shrink in castings. We were always careful to have sufficient of the same iron mixture on hand for the castings in question. When making columns the foreman found that if the metal was poured colder in one case than another, there was a difference in contraction. We were careful to reach the same temperature of the molten iron just before pouring the columns.

Mr. Newcomb: I believe the cleaning can be very materially hastened by the use of the sand blast. I have had it in use for more than a year, and I find that it enables me to have the castings cleaned very rapidly.

When a casting is cleaned by means of the sand blast before the chipping and inspection takes place, it brings out the imperfections, and the inspector has better opportunity to note the imperfections, and it enables him to get the information before the foundry foreman much quicker than by any other process of cleaning that I am familiar with.

Any process that will bring the imperfect casting to the foundry foreman's eye in the shortest possible time after the casting is made is an advantage. If it is a casting that is made and cast in one day it can usually be cleaned, in nice shape, in fifteen minutes, thus giving the foundry foreman an opportunity to correct any mistake before another casting is made.

If the casting is so large that it requires three or four days

to complete its molding, then such a casting could be cleaned in a few hours, and it could be readily inspected and measured to see if it was true to pattern and all right in every respect, leaving ample time to make corrections the first day after casting has been poured.

I think all foundrymen inspect their castings to a greater or less degree. The great trouble is that it is not done in a systematic manner and there is a total lack of method in most foundires, especially in jobbing foundries.

Mr. Putnam has pointed out that a place, an inspector and a system is needed, and then good results will be obtained. It is evident to all that all of this should be introduced into large foundries, but for the small jobbing foundry, or a foundry on special work (making a cast of 15 tons per day), the foundry foreman has to cover the ground. Therefore the foundry foreman in such cases should be systematic and methodical in making inspection. Such inspection should be made before 12 o'clock every day, and in most cases it can be done if a sand blast is used to clean the castings; arranging to clean those that needed the most critical inspection early in the morning, and facilitate cleaning by having all castings taken out of molding department into cleaning room before 7 a. m., and I find this method profitable.

Mr. Auger: There is a field of castings which cannot be covered by any inspection; such castings as the foundries in the air-brake business make. For instance, a brake-cylinder, made in large quantities by a good many different men, and on the piece-work system. In our casting, the losses have to be followed very carefully, as in most cases they cannot be detected until the castings are partially machined. While we try to machine as soon as possible after the castings are made, it is necessary, often, for several days to elapse. The system we follow is one that has given thorough satisfaction, and I thought some of you might be interested in it. Our castings are such that it is possible to watch them through the machine shop. Each molder has his mark, which is cast on the castings. The larger castings

also have dates cast on them, and the smaller castings are dated after they are ground. A record is turned in each day to the superintendent of the foundry of the number of pieces put up and passed through the cleaning room, for which each man is given credit. In the machine shop all bad castings thrown out for defects are placed one side. At the end of a week our inspector goes through and takes a record of all castings rejected from the machine shop. He records the molder's mark, the date on which the casting was made, and the cause for which it was thrown out. It may be a blow-hole, a shrink, cores improperly placed, poured too hot, or too cold. The troubles are tabulated under the proper head, and posted in the foundry. Each molder knows how much he loses, and the cause of the rejection. A good deal of it might be charged directly to the molder; or it might be due to the sand or some other cause. This we correct by careful watching and early cleaning. The defects chargeable to the molders are charged back to them, and the reduction made from their piece work. Of course it means some system and some work, but it has reduced our losses enormously.

Mr. Putnam: I am aware that the position taken in my paper is extreme, and that its adoption in its entirety would be, in most foundries, impracticable. I know of one foundry where it was followed for many years with very gratifying results. But the remarks of all these gentlemen, it seems to me, corroborate my main contention, viz., that the sooner the inspection follows the cast, the better for both the employer and the workman; and I believe that foundrymen would find it profitable to give much more thought than has been customary to this branch of the business.

The Chairman: If there is no further discussion, we will turn out the lights and have Mr. Knight's illustrated paper on "The Micro Construction of Iron and Steel."

Mr. Knight then read the following paper:

THE MICRO-STRUCTURE OF IRON AND STEEL.

By S. S. KNIGHT.

Since systems of testing have become so numerous and so many are possessed of such seeming merit, engineers and constructors have been forced to pause a moment before closing the specifications that they are drawing up and give attention to what means shall be used to determine whether the purchased product shall have the desired properties.

It has long been felt, in the world of iron and steel manufacture, that the time-honored tests for fiber-stress, tensible strength, elongation under load and the determination of the elastic limit were not sufficient to insure the acquisition of material to meet special requirements, hence the foremost investigators turned with enthusiasm to the chemical laboratory as a means of supplementing the tests before mentioned. It is needless to add that even here they were somewhat disappointed as in the case of the carbon compounds of steel, the science of chemistry could not make a distinction between the ordinary cement carbon and that so familiarly known as hardening carbon. As an example, let us consider a steel rod which for convenience we will analyze and cut into two pieces. One part we will call A and the other B. The analysis showed that this rod contained .340% of carbon which, of course, was all combined, the phosphorus was .106% and the manganese .553%. A was placed in a furnace and heated to a moderate redness or 700° centigrade, while B was heated to about 1200°. Both were thrown upon the ground and allowed to cool slowly. They were then taken and submitted to a strain of 45,000 pounds, each piece thus strained being eight inches long. The original diameter of the rod was nine-sixteenths of an inch. Under the stress A elongated .65″ and B but .13″, or one-fifth as much as A. A subsequent analysis showed that the carbon content had not changed and the Eggertz method could make no distinction in regard to the compounds of this element with the iron in the two bars.

This case only shows how limited were the advantages to be

derived from the possession of chemical facilities, and although they are of far more value at the present time than they were one year ago, yet the science has not been perfected to such an extent that its exponents need feel any alarming gratification when it comes to distinguishing between the various compounds of carbon and iron. Even if it were able to do this, it could only give us the composition of the material from a chemical standpoint, so that the discovery of what processes it was submitted to in its manufacture would still come under the domain of some other science. Hence engineers, who had so often found faulty steel of the correct chemical composition, but wholly lacking in those physical properties which had been so commonly found in similar stock, and which had been so particularly desired in the material in question, turned with a new zeal to the recently discovered process of determining the mechanical properties of steels by a system of mechanical analysis. It is this new departure with which we have to deal to-day and which we shall proceed to investigate.

We have called this new method a system of mechanical analysis, and it may be interesting to know that this was the identical terminology used by its inventor, Dr. Sorby. The very name leads those interested to suppose that, like other mechanical and unlike chemical means of testing, this system would become popular since its name made the uninitiated to suppose that it was free from scientific terms. As usual, such was far from the case and the doctor's system of testing by reading or studying the fractures of metals with the naked eye or low power magnifying glasses soon grew into science with a terminology of its own, and in place of the simple magnifying glass came the compound microscope.

Let us note before going further that the difficulty of performing a test will detract nothing from its intrinsic merit. It may, however, and quite often will so limit its field of actual utility that ofttimes where it could be used to the best advanage, it will be dispensed with solely because it is of such a nature that it is inconvenient to perform. This difficulty may arise from either of two causes or from a concurrence of both; first, the

necessity of possessing costly apparatus, and second, the requirement of specific knowledge or obscure technique.

It is probable that no test has ever been devised in any class of work which possessed both of these difficulties in so marked a degree as that with which we have to deal in the present case.

To the unobserving it may have appeared that iron and more particularly steel is nearly homogeneous. Homogeneity is of two distinct kinds, which we may loosely call molecular and molar or, more properly, chemical and mechanical. It must be kept in mind, however, that the presence of one in no way indicates or necessitates the presence or absence of the other. Thus two pieces of carbon might, in some manner, be held together which hypothesis would necessarily make them chemically homogeneous and yet one might be a brilliant, glittering diamond while the other was but a shapeless lump of black graphite. In this case one would be crystalline and the other perfectly amorphous. Happily, however, for the investigator, this latter condition cannot exist among metals, since crystalline forces on one hand and strains of tension and compression on the other, superinduced by a dissimilarity of thermal conditions, give rise to definite geometrical elements of physical constitution in every metal. According to Osmond, "these elements may, moreover, assume perfect crystalline forms, with their planes of cleavage well defined and highly distinct; or embryonic crystalline forms, segregated in the midst of a conglomeration of confused organization, which is the more common case, or pseudo-crystalline forms of expansion and contraction like those produced by the drying of gelatinous precipitates (as most frequently seen), all of these different forms associated.

You grasp at once the magnitude of the field to be covered by the science which uses the microscope in interpreting the surfaces and fractures of metals. In fact, the entire science of metallography has grown exclusively out of the study of fractures and the desire to correctly read them. The science is young, is but a thing of yesterday, and although we do not know what it embraces in its scope, nor can we predict what its future will

be, yet we can say with absolute certainty what advantages may be obtained from its use to-day.

It is not necessary to consume your time with a history of this science; it will be sufficient to say that Dr. Sorby was its founder, and that under the influence of his writings and works it has grown to such an extent that where its originator was able to use but nine or ten diameters of magnifying power upon his specimens, the exponents of his system to-day can use upwards of one thousand diameters with excellent results. This rapid progress has been due, in a great measure, to the untiring efforts of Messrs. Martens, Osmond and a score or more of others. Like most sciences, it started in the laboratory, and has steadily grown and extended until we find it used to-day as a supplement to chemical analysis and physical testing in every country upon the globe having large metallurgical interests.

We would not wish to assume the criterion of speaking for American metallurgists, but a quotation from Prof. Stillman, who is an acknowledged authority on all questions pertaining to engineering, will show in what high regard he holds this science. He says, in part, "Microscopic examinations of iron have led to remarkable developments of our knowledge of its structure." Recent investigations have shown that eminently practical results are to be obtained from microscopic examinations.

As an illustration of its commercial value, let a discovery made by one of the foremost German microscopists of to-day be considered.

Baron von Juipter, while studying the deterioration of steel rails in actual service, found that before the complete annihilation of the structure obtained by heating and working took place, or coincident with it, that the end of the rail bolted between the fish plates would begin to show microscopic cracks or fissures. Further study of this phenomenon proved that the original structure could be restored by simply giving the rail proper thermal treatment. It will be understood that to accomplish this end no rolling or mechanical operation would be required, the proper degree of heat correctly applied fully attaining this end.

It had long been known that in iron in the refined state or as

steel at least two mechanically different substances existed. These were supposed to be pure iron and iron in combination with carbon. This old theory was true enough for steels without temper or those that had never been subjected to heat treatment. As more attention was given to steel and its behavior under various conditions, some startling facts were discovered. As regards our present topic, it will be sufficient to note but two of these.

The first is that when any steel that is rich in carbon is slowly heated by any constant source of heat, the temperature rises uniformly or as the length of time that the heat is applied, until a point in low redness is reached (680° to 720° centigrade), when the material ceases to continue to uniformly increase in temperature and remains for an appreciable time the same color. After a time the temperature continues to rise uniformly again as if no disturbing influence had been felt. This it may do until liquifaction takes place, but usually lesser retardations occur as the temperature rises. In cooling the opposite phenomenon takes place, the color gradually leaving the steel until the same point is reached, when the metal assumes a sharp and distinct glow, which soon subsides and the cooling continues in the previously described manner. These points where the retardations take place are called the W and V points by Howe, and are designated by Osmond as Ar, or in cooling the points of recalorescence.

Without entering too deeply into the character of this phenomenon, we may assume that the only retardation that takes place occurs at the W or V point, although as just shown such is not the case. Osmond explained this phenomenon by asserting that the change which took place was from the ordinary iron to a special hypothetical, allotropic form, which change, of course, consumed heat, hence the retardation. As it was known that a sample quenched from a higher temperature than this point would be greatly hardened, Osmond gave this allotropic form of iron a property of increased hardness and claimed that the quenching did not allow a sufficient time for the iron in this hypothetical state to change back to iron in the ordinary state. It was also known that the increase in hardening, due to quenching, was roughly proportionate to the amount of carbon that

the steel contained, but this was reconciled to this theory on the supposition that the carbon clogged the action or change from one form of iron to the other.

This same phenomenon explained from a microscopic examination would be very simple and, above all, would rely solely

FIG. 1.
SERIES I, 2a—Annealed at 1015° C; Vertical Ill. x30; Carbon, .14 %.

FIG. 2.
SERIES I, 2c—Annealed at 1015° C; Vertical Ill. x200; Carbon, .14 %.

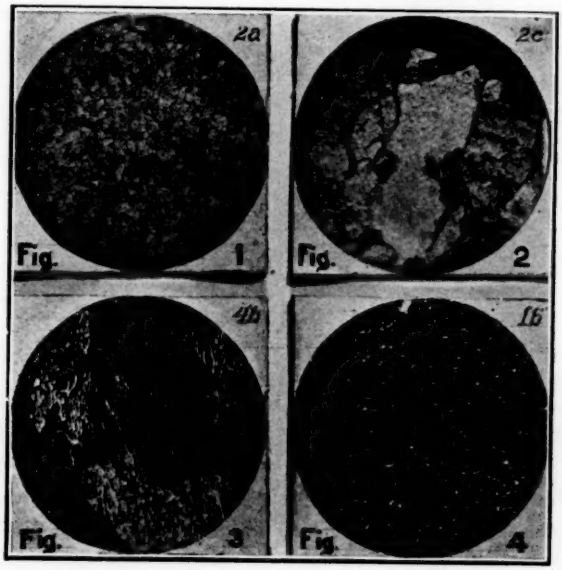


FIG. 3.
SERIES I, 4b—Annealed at 1360° C; Oblique Ill. x30; Carbon, .14%.

FIG. 4.
SERIES I, 1b—Hammered; Oblique Ill. x30; Carbon, .14%.

upon observed and known facts, instead of wholly upon an hypothesis that from its very nature could never be verified. The retardation would be seen to be due to the changing of composition which takes place in the carbon when it is subjected to a heat greater than 700° C.

The process of preparation for this examination would consist in making a button from the stock which is to be quenched

and also one from the same material after it has undergone this operation. These buttons are sections of $\frac{1}{8}$" thickness and any convenient diameter. After being turned out on a lathe they are mounted upon a glass slide such as is used for ordinary microscopic work and then placed in a chuck which securely

FIG. 5.
SERIES IV, 1b—Showing Cementite; x10; Blister Steel.

FIG. 6.
SERIES IV, 2b—Details of Cemtite; x60; Blister Steel.

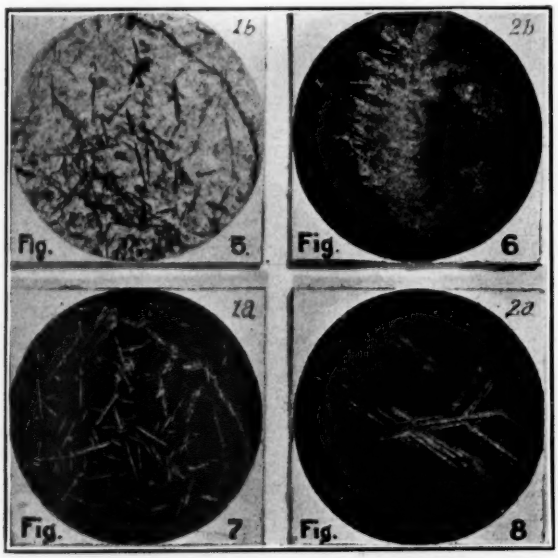


FIG. 7.
SERIES IV, 1a—Showing Cementite; x10; Blister Steel.

FIG. 8.
SERIES IV, 2a—Details of Cementite; x60; Blister Steel.

holds them. The surface is then ground off on an emery wheel, finer and finer wheels being used as the operation proceeds. The surface is then polished with emery flour, calcium carbonate, and lastly with washed rouge.

Under the microscope these buttons will show two entirely different structures. The first will show pure iron, which is known as ferrite, and some of the many compounds of iron and

carbon. This ferrite may be seen nearly pure in malleable castings. When relief polished it retains a dull polish, but becomes massive as the process is continued; this appearance fades away and it becomes granular, sometimes resolving into the massive structure again under higher magnifications.

No. 1 shows the granular structure of ferrite and is a sample of .14% carbon steel which was annealed at 1015° C. No. 2 shows the massive structure above referred to under higher magnifications, the ferrite being in the form of large polyhedral crystals and the specimen being No. 1 magnified 66 times more than as shown before. The illumination in both cases was vertical. No. 3 shows the same steel annealed at 1300° C. under oblique illumination. The dark portions are those protected from the light by the irregularities of the surface. No. 4 is the same steel hammered, the illumination being also vertical. The granular structure is especially worthy of notice. This ferrite remains uncolored when etch polished with calcium carbonate or when etched with tincture of iodine.

Besides the ferrite just spoken of four other distinct forms are known to microscopists. All of these are in a greater or less extent compounds of carbon and iron. The most commonly seen of these is the variety known as cementite, which is supposed to be a carbide of iron of the formula Fe_3C. It was formerly supposed to be the hardest of all the compounds of carbon and iron, having a hardness about equal to that of felspar. It is believed to be identical with the hard components of both cast and forged steels. Like ferrite, it remains uncolored when etched with tincture of iodine. The appearance of this constituent is often very deceptive, and its tendency to appear as scratches or fissures is likely to lead the neophyte astray. No. 5 shows a portion of a button of blister steel, which will at a glance show the appearance of which mention was just made. No. 6 shows a portion of the same field shown by its immediate predecessor, the magnifying power having been increased ten times. The detail of the supposed scratch is clearly shown, the illumination in both cases being vertical. It will be seen that the beginner would be apt to take the appearance

just spoken of as an evidence of the incompletion of the polishing process. Such, however, is not the case and is a strong point in favor of the frequent inspection of the sample while being ground. No. 7 and No. 8 are also specimens of stock similar to No. 5 and No. 6, the cementite being shown in detail in the latter. It will be noted that what appeared as a cloud in No. 6 appears as distinct structure in No. 8. Also notice regularity of the various angles formed by the intersection of the monoclynic needles. In all of the last four specimens shown, the homogeneous structure of the ferrite or matrix in which the cementite lay, is a point worthy of attention.

Another of the compounds of iron and carbon has long been known as pearlyte, on account of its nacreous luster. When viewed with upward of five hundred diameters of magnifying power, under vertical illumination this constituent may be resolved into flakes of hard and soft material lying in alternating lamillae or strata. Formerly this substance was divided into two kinds, known as granular and lamilar pearlyte. This terminology has entirely disappeared and in its place has come the word sorbite, in honor of Dr. Sorby, who, as will be remembered, was spoken of as the founder of this science. It has been clearly demonstrated that this sorbite is not of the formula Fe_3C, as originally supposed, since when etch polished the color changes from yellow to light brown and then from blue to purple, and at no time as the change goes on is the color homogeneous. It has been suggested, and with reason, that this constituent may have the formula $Fe_{10}C$.

Still another compound, which is of recent discovery, is termed Martensite, after the noted German microscopist, Prof. Martens. It is always present in iron that has been quenched from above the point of recaloresence, and requires etch polishing to bring out the structure, which is usually seen in the form of faccicles or collections of parallel rectilinear fibers. The matrix in which these fibers lie may be ferrite, containing a small amount of emulsified carbide of iron of uncertain composition or may appear to be intersected by short irregular lines. Osmond believes that what is now called martensite is not a definite com-

pound of carbon and iron but rather an allotropic form of iron in crystalline arrangement, under the influence of carbon. This theory seems, however, strained to suit the one proposed by the same author in regard to the retardation in heating or cooling high carbon steels. This theory of crystalline arrangement finds some evidence in its support, from the fact that martensite is often seen as groups of fibers in bundles of three, running parallel with the sides of a triangle, as is the case in bodies which crystallize in the cubical system. Martensite may not always be identified by etch polishing, as sometimes it is not colored and then it takes but a light yellow sheen. Tincture of iodine causes it to take a yellow, light brown or black color according to the carbon content of the steel being examined. It is partly on account of this irregular manner of receiving color that it is disputed whether it is a fundamental compound or not.

The last and in many cases the least known of all the microscopic constituents of steel is troostite, so-called in honor of the noted French microscopist, Dr. Troost. This compound may be found in properly quenched medium iron, and if etch polished, nodules appear in relief together with strips or orientations of ferrite, while between these may be seen intercalations of moderate hardness and varying depth. These bands show temper colorations which produce an irregular spotted appearance not unlike the surface of a spotted marble. The strangest characteristic of this constituent is that it is almost amorphous, and sometimes slightly granular but never stratified.

Coming back to the peculiar behavior of steels and the facts that have been discovered in observing their deportment under various conditions. The peculiarity of recaloresence we have considered, the other of which mention was made is now before us.

The art of tempering steel has been known for centuries, but the nature of this process has not until recently been demonstrated. The fact that a bar of steel can be heated and cooled and by this process have its physical characteristics changed without altering its chemical composition seems in itself to be strong evidence that a change of no mean dimensions must have taken

place in its structure. Before the utilization of the compound miscroscope it was impossible to obtain any definite knowledge concerning this change, but its use supplemented by careful chemical analysis has done much to unravel this mystery. It was formerly supposed that when a piece of tool steel was heated above moderate redness and quenched, that the sudden cooling

FIG. 9.
SERIES II, 2a—Annealed at 750° C; Vertical Ill. x30; Carbon .45%.

FIG. 10.
SERIES II, 2c—Annealed at 750° C; Vertical Ill x200; Carbon .45%.

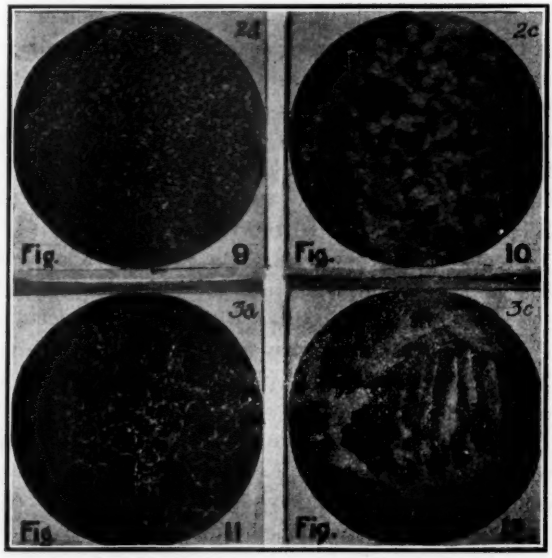


FIG. 11.
SERIES II, 3a—Annealed at 1115° C; Vertical Ill. x30; Carbon .45%.

FIG. 12.
SERIES II, 3c—Annealed at 1115° C; Vertical Ill. x200; Carbon .45%.

in some manner made the molecules of iron come into closer contact, and hence so greatly augmented its density. This theory was, however, ridiculous since the volume of any material thus treated was also increased. Microscopic examination showed that the real cause of hardness was the formation of a subcarbide of iron of the probable formula $Fe_{24}C$. This compound decomposes in the presence of the most dilute acids

into the normal carbide of iron and pure iron which appears under the microscope as ferrite. This subcarbite of iron possesses almost diamond-like hardness and also a great capacity for permanent magnetism. Its decomposition may be affected by annealing, and in such cases it is to be remembered that the temperature need not be higher than moderate redness as it has

FIG. 13.
SERIES II, 1a—Hammered; Vertical Ill. x30; Carbon .45%.

FIG. 14.
SERIES II, 1c—Hammered; Vertical Ill. x200; Carbon .45%.

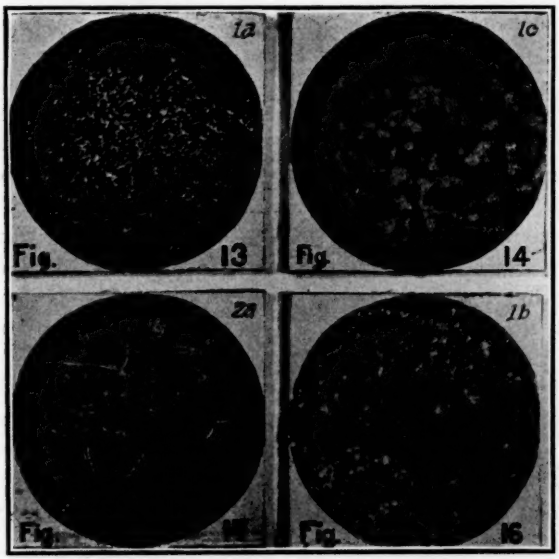


FIG. 15.
SERIES III, 2a—Annealed at 1330° C; Vertical Ill. x33; Carbon 1.24%. (Light piping ferrite; 1330° C; Burnt Steel.)

FIG. 16.
SERIES III, 1b—Hammered; Oblique Ill. x33; Carbon 1.24%.

been found that this carbide is decomposed by a temperature of as low as 400° C. It is readily seen, from the above facts, how quenching may harden and annealing soften any steel which has a high carbon content.

Following this same phenomenon a little further, the above facts also constitute an explanation of why heating to dull red-

ness will invariably destroy any permanent magnetism which a steel may possess. It is only necessary to keep in mind the capacity this carbide has for permanent magnetism and its low temperature of decomposition in order to have in hand all of the causes which are operative in bringing about this seemingly strange result.

While considering this form of carbon and iron combination, it will be apropos to spend a moment on another phenomenon commonly known as case-hardening. This process has been indiscriminately called a carbonizing or a phosphorizing one, according to whether the material to be case-hardened was packed in charcoal or bone-meal. As is well known, the depth or extent of this surface hardening is in proportion to the amount of time that the incandescent material is kept in contact with the packing, and also varies with the kind of filling used. The fact that is most worthy of our attention is that no hardening takes place until the material is quenched, and the higher the temperature at which this quenching occurs the harder will be the material thus treated. In order to determine if this process consisted in phosphorizing or carbonizing the stock, a bar of low carbon steel was cut into two pieces, one being retained as found and the other heated with the packing along with other work, being case-hardened for three successive days. At the expiration of this time a sample of each piece was taken into the laboratory and analyzed for carbon and phosphorus. The analysis showed the following results:

	Original Stock.	After being Case-hardened.
Phosphorus	.006%	.006%
Carbon	.0768%	.225%

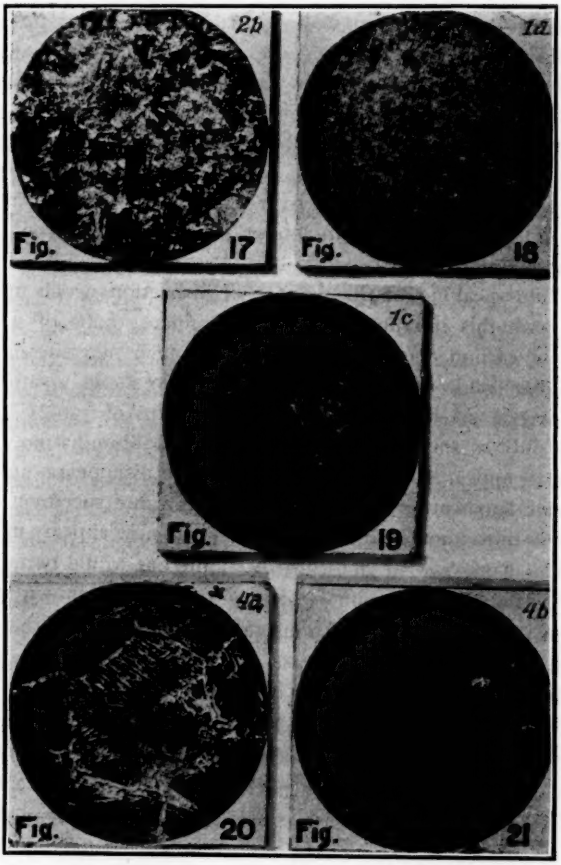
In the original stock this carbon proved to be in the form of the ordinary carbide of iron (Fe_3C), both from microscopic and chemical tests. The case-hardened piece was then heated and quenched until it was so hard that a file could scarcely cut it. An examination was made to ascertain in what state the carbon now existed and again both microscopic and chemical tests were

FIG. 17.

SERIES III, 2b — Annealed at 1330° C; Oblique Ill. x33; Carbon 1.24%. (1b and 2b—extreme variations due to heat; light ferrite)

FIG. 18.

SERIES III, 1a—Hammered; Vertical Ill. x33; Carbon 1.24%.



F.G. 19

SERIES III, 1c—Hammered; Vertical Ill. x225; Carbon 1.24%.

FIG. 20.

SERIES II. 4a—Annealed at 1030° C; Vertical Ill. x30; Carbon .45%.

FIG 21.

SERIES II, 4b—Annealed at 1330° C; Oblique Ill. x30; Carbon .45%.

made, with the result of proving beyond a doubt that the carbon had changed from the ordinary carbide form into the almost diamond-hard sub-carbide of iron of the formula $Fe_{24}C$.

As mentioned before, one of the greatest advantages of using this system of miscroscopic investigation is the certainty with which the manner of working the stock may be told. Thus a sample of the steel rod which was spoken of could be sent to any part of the world and the microscopist making the examination would know that A had been subjected to a temperature suitable for the working of stock carrying .34% carbon, and that B had been heated to a temperature far in excess of this safe limit, and was no longer suited to the purposes for which A could be used.

While speaking of the manner of inspection which may be done with this instrument, some photomicrographs of steel of different carbon content will show how much of value may be learned by means of the microscope. No. 9 shows a sample of .45% carbon steel annealed at a temperature of 750° C. magnified only a small amount under vertical illumination. The granular appearance is to be noted as it disappears under a higher magnification. No. 10 shows this same specimen magnified 66 times more than No. 9. The ferrite now appears in large irregular flakes not so uniformly distributed as would be inferred from No. 9. Another sample of this same steel is shown in No. 11, this time the annealing having taken place from a higher temperature, 1115° C. In this case the ferrite is seen as ramified needles lying at all angles to each other. No. 12 is the same specimen under a magnification 66 times greater, the ferrite again appearing in irregular flakes. No. 13 and No. 14 are specimens of the same steel which have been subjected to treatment under the hammer, the ferrite showing as in the previous illustrations.

Coming now to heat treatment, we see in No. 15 a sample of tool steel containing 1.24% carbon which has been annealed at the high temperature of 1330° C. This steel shows the effect of this burning in the light piping ferrite, which is an infallible

sign in any steel that it has been subjected to too high a temperature.

No. 16 is another sample of this high carbon, this specimen being hammered. It is shown in oblique illuminations, the ferrite appearing as light flakes. No. 17 shows the other extreme of temperature for this same stock, it having been annealed at 1330° C. Here the ferrite again assumes its characteristic appearance in burnt steels, the illumination being also oblique.

We now come to No. 18, a sample of the same stock having been hammered. The ferrite seems to be more finely divided, and this conclusion is substantiated by the same specimen as seen under a magnification 66 times as great as shown in No. 19. Here the ferrite appears as a cloud and this structure always indicates a strong and uniform steel.

No. 20 shows a sample of steel containing .45% of carbon which has been subjected to a temperature too great for working. The ramifications of the ferrite are beautifully shown under vertical illumination, while in oblique illumination the structure appears less certain, No. 21.

Coming back to heat treatment and its effects upon steel in general, there is no more remarkable discovery that has been made in this field for many years than the explanation of the phenomenon of water-annealing. This heretofore inexplicable process is now accounted for in the most commonplace manner by means of the facts recently found out by the microscopic examination of iron.

If the end of a bar of iron be heated to a light redness and quenched in water, while the other end be left cold, it will be found that there is a place along the bar where the hardness is less than it was before the heating, although the end most highly heated be so hard that a file cannot cut it. It is now known that the increased hardness is imparted to the steel by the changing of the normal carbide of iron to the sub-carbide. This sub-carbide existed in small quantity in an emulsified form in the original bar, thus giving it what hardness it possessed. Now, as this sub-carbide decomposes at so low a temperature, there is a place in the bar where what little sub-carbide did

originally exist, is changed into the normal carbide and thus the determination of that portion which will be water annealed. As the temperature rises this normal carbide would be retransformed into the sub-carbide, but as this rise at this point never takes place, the carbon is left in this intermediate form.

The use of the microscope in cast iron work will not be as easily demonstrated as in the case of steel, for in this field we have to deal with more fundamental forms, both of crystallization and chemical composition. The presence of one of these, graphitic carbon, greatly complicates the process and renders the microscopic examination of cast iron far from easy for the beginner. This in no way lessens or modifies the value to be received from its use but renders the possibility of its becoming popular less certain.

Possibly no character of work could afford a better example of the value of the adaption of microscopic metallography to foundry work than a brief description of its use in the manufacture of the so-called gun-iron. As is well known, the only requirement of this metal is its high tensile strength, which should be over 30,000 pounds per square inch. Thinking that some other data would be of interest, a few other measurements have been made, which will be seen to be quite nearly allied to similar tests made upon the common iron used daily for ordinary castings. These bars were pulled and broken without any finishing of any kind, except No. 1 and 2, which were accurately turned down to size, the others being taken from the mold and rattled to clean off any adhering sand.

	Tensile Tests.		Transverse Tests.				
No.	Meas'm'ts.	Brk. Str.	Meas'm't.	Def.	Sh'kg.	Brk. Str.	H'd'n's.
1	Area 1 sq. in.	34700	.563x.563″	.100″	.140″	1500	237°
2	Area 1 sq. in.	35400	.563x.563″	.080″	.145″	1490	236°
3	Area 1 sq. in.	33770	Shrinkage was measured on 1 lineal ft.				
4	Area 1 sq. in.	32430	Deflection was taken at 1000 pounds.				

These bars show a shrinkage slightly in excess of that ordinarily seen in cast iron and a hardness slightly above that of material suited for common machine work. Bars No 1 and No. 2 were pulled on an Olsen machine, while all other tests were

made upon a Riehle machine except the hardness determinations, which were made upon Mr. Bauer's hardness tester.

In explanation of these results it must be remembered that all such metal is made of a small percentage of steel scrap, and that this material is low in carbon as compared with cast iron. But it must not be inferred that the consequent reduction of the carbon content, due to the addition of the steel accounts for the increased strength, for such is not the case. The combined carbon of cast iron does not exist in the same form as that which is found in the steel. Thus the carbon that exists as normal carbide of iron in pig-iron, which is both soft and weak, when melted with steel or light cast iron scrap in a cupola where the metal comes into contact with the incandescent fuel, will be changed into one of the more complex forms of iron carbide, and may be identified as such under the microscope. It will thus be seen that in order to have an iron of exceptional tenacity it is only necessary to have a certain amount of these higher carbides of iron present, providing that the analysis of the metal is somewhat similar to the following:

Silicon	.75% to 1.00%
Sulphur	.030% to .07%
Phosphorus	.250% to .300%
Manganese	.400%
Comb. Carbon	.750%
Graph. Carbon	2.000%

If for any reason an iron should have such an analysis and yet not have the desired strength, it is only necessary to examine it and see if the higher carbides of iron may be seen, and if so whether they appear to be uniformly distributed throughout the mass. If not the mixer of such metal should at once take steps to bring about the increase in these carbides, which may be done in a number of ways.

And so examples might be brought ad infinitum showing the benefit which may be derived from the use of the microscope in the hands of a competent man. Want of time prohibits our going further into the investigation of this science at this time. The

subject has necessarily been tedious to all who have not had at some time an opportunity to see for themselves the vast field which is open to study and improvement through the use of this instrument. However, it affords delight to me to be able to say that so much advancement has been made in such a comparatively short time. The science has an unlimited field before it, and it only remains to be seen how much benefit will be derived from its use in the future. It has been of this much value already that by its use we have been placed in possession of facts which explain phenomena which before appeared apparently without cause.

N. B.—All photomicrographs are from reprints of those made by M. Frances Osmond, of Paris, France.

Mr. Bauer: I think there is no doubt but that this line of research is adapted to the malleable iron and gray iron fields, as well as the steel field. I have in mind a little example where this system came into play and brought about good service. It does not bear directly upon foundry practice, but I should like to give it as an example to show that there is something in the method. We had a piece of refined iron some time ago which gave considerable trouble. The analysis of that iron gave us exactly the same result as obtained on previous lots that did not show the defect this iron had. We were unable to discover chemically what was making that difference. These buttons, when we examined them under the microscope, showed widely different results, one button showed very plainly the lines we saw in the hexagon figure on the screen you remember; that was the good refined iron, but when we looked at the other button we found that all these lines had been destroyed in the working of the iron.

The chairman: I called on Dr. Moldenke, expecting he would say that the paper strengthens the feeling on the part of the founder that instead of a chemical analysis only, he would like to get a sight of the iron, and thus possess the missing link which would make him a more ready believer in results obtained by analysis.

Mr. Gates: I think we can get something of that by simple photographs. We have found that we can see the grain of the iron much better in a photograph than with the ordinary eye or with an ordinary magnifying glass. There is something in a photograph which seems to bring things out much better. A strong microscope would help to bring it out.

Mr. Lanigan: Can any one tell why on remelting old car wheels the chilled iron will be found on the top surface of the casting as it lays in the mold, providing the casting is of any weight?

Dr. Moldenke: Iron and steel will float, but only as long as air sticks to it. I have noticed this with malleable scrap. It was thrown into a bath and kept on floating there until bit by bit it went under; there was so much air sticking to it.

The Chairman: Many different opinions are held upon this question.

Mr. West: The question is one of specific gravity.

Mr. Lanigan: At our last meeting I asked a chemist why in making a casting of a wheel it invariably happened that the chill hardening was on top of the casting. Any man that owns a foundry can test that. He can make his cast of a wheel and plane it off, and he always finds the chill at the top of the casting. Now. if anyone can explain chemically why that happens he is a wise man.

Mr. Seaman: I possibly melt as much chilled iron as anyone here. I make chilled rolls, and it is to my interest to take an old chilled roll and melt it over again and make a new roll. But the question of taking an old roll and melting it over with pig added to it and finding any difference between top and bottom of that roll is new to me, and I have to see the first one yet showing that difference.

Mr. Lanigan: I am asking that question from experience.

Mr. Frank: For the benefit of the Association, I will institute some experiments on this point and report next year.

The Convention then took a recess until Friday morning.

FRIDAY MORNING SESSION.

The convention was called to order at 10 o'clock.

In the absence of the author, Herbert M. Ramp, his paper was read as follows, on "Trolley Systems—Their Value in Foundry Work."

TROLLEY SYSTEMS—THEIR VALUE IN FOUNDRY WORK.

By HERBERT M. RAMP.

The overhead trolley system is one of the most modern of improvements in the foundry and connecting departments, and bids fair to almost entirely supersede all other methods of carrying and handling light as well as heavy loads. Their adaptability to all kinds of work, the ease with which they can be operated, the amount of labor they can save, and the nominal cost at which they can be erected, have opened a wide field for their use, and it can be truly said that when properly erected there is no machinery placed about a foundry and machine plant that can demand better claims to being classed as "labor saving" and "dollar saving" machinery.

This is the evolution of the crane, and the trolley system is gradually crowding these clumsy, ill-looking, room-consuming creatures of the past to the wall, and while there have been wonderful improvements in our cranes, they cannot expect to equal the modern trolley system. The advantages of the same are great, and a few of its good points are as follows:

First. It will cover more territory at a lower cost; second, it will work quicker than any crane built; third, it can be operated more easily and with less labor than a crane; fourth, it can be erected and operated in places where a crane could not; fifth, it is maintained at a lower cost for repairs than cranes; sixth, it is unlimited. You may extend it to any length or over any space you desire at any time, while a crane is complete within itself, and when more room is required, you must build a new and separate crane; seventh, it consumes no room like a crane does. The entire track is hung from the roof or supported by columns, while a crane swinging in a circle has at least a fifteen-foot circle in the center that is useless, and does not reach the corners; eighth, it requires no heavy foundation and is not a strain upon the walls of the building, pulling them out of shape with the roof also, as many a crane has done. When used in con-

junction with air-hoists and compressed air, there is absolutely no question as to its value, and any concern that does work which requires any amount of heavy lifting or crane work, can pay for the entire expense of erecting a suitable system in one year's time by the labor saved and confer a favor of no small proportions upon their men by relieving them of the heavy, hard, laborious part of their duties.

How many have stepped into foundries, those who are conversant with the business, and watched the great, cumbersome twenty or thirty-ton traveling crane expend its force, time and wear on machinery to lift a little casting or flask that would not weigh over a thousand pounds, while other men stood waiting for it, consuming twice the amount of labor and time a good trolley system would? Is this economy? True, the heavy crane has its place, but there is much more light lifting and handling than there is heavy, and the wideawake, progressive foundrymen of the day will make other provision for handling light loads quickly and cheaply. We have seen molders and helpers stand for ten minutes around a large flask waiting for a lift because there was no room under the crane, and such work had to be made on the side floor anyhow because the crane was so slow. How many foundrymen ever stop to figure what that lift cost and what it would cost if he had a trolley system and compressed air, so one man could handle it himself; and how many such lifts are made in a foundry in a year? If you do, you will find the figures surprising. You have noticed men pulling and struggling to get heavy cores from the core room to their molds. Yes, and we see a dozen places every day around a foundry where this device would save labor, money and time.

Trolley systems can be erected to run from the cupola or standing ladle direct to the floors, and ladles holding from 600 to 1,500 pounds of iron easily handled and poured by the molders, saving the labor of helpers to carry the small ladles, and being a great advantage in being able to more nearly put the exact grade of iron in each class of work than when carried by hand. It also reduces confusion in the shop at casting time for fewer men are required to handle the iron and fewer ladles are in operation

at one time, and last but not least, your men will end their day's work fresher, be able to accomplish more of it and do it better, because their physical abilities will not be exhausted by the hard hot labor of carrying iron. If it is expected for men to do more work or better work, and the condition of times and nature of competition make this a necessity, take the hard labor from them, the heavy lifting, the wearisome iron carrying, and you instantly put them in a condition to do more work and also to do it well.

These same tracks can be utilized for all kinds of crane work, any number of trolleys can be run upon the tracks, and every molder can have a crane to himself and never be put to the trouble of waiting or changing rigging. The tracks can be run to the core room, and all heavy cores handled direct from them to the molds, also saving the coremakers an immense amount of time and toil by having facilities there to handle the heavy cores and plates. This same system can be run to the cleaning room and the castings removed from the foundry by its use, and from there direct to the machine shop. In fact, in many places around such plants the thing can be utilized to a wonderful degree.

The Crescent Iron Works at Springfield, Missouri, recently erected a trolley track outdoors for the purpose of loading and unloading cars. It was composed simply of a number of columns 24 feet high set in V shape inverted, which carried a 15″ "I" beam upon which the trolley runs. A 16″ air hoist six feet long was attached to the trolley. This was comparatively a cheap structure and will pay for itself the first year of its operation. Formerly when an engine or boiler was to be loaded, or any machinery or castings, it was accomplished by hand. Now it is run under the trolley track on a truck and four or five ton loads are picked up and loaded on the cars by two men in almost as few minutes.

There are a number of different styles of trolley systems, many of which are good, but the double rail is always preferable. In the April and May issues (1896) of THE FOUNDRY, the writer showed several different types, one with wrought iron rails

and cast iron hangers, and the other with both cast iron rails and hangers, both of which have been tried by hard service and found very satisfactory. These tracks cost about $1 per foot erected. A western concern about four years ago put in 400 feet at a total cost, including switches, of $400. This was principally used over heavy side floors and on light crane work and the saving in labor, including carrying iron, is fully $400 per annum, or the cost of the structure. It covers eight floors and is not used on all of them at one time, will not average over four constantly, which makes this facility worth $100 per annum per molder when in use constantly. It is not safe to assume that every investment of this character will yield 100% profit in a year, but it is safe to assume it will return not less than 30% per annum.

The Murray Iron Works, at Burlington, Iowa, the Atlas Engine Works, of Indianapolis, Ind., use similar tracks, and from observations as to the use they put them and their probable cost, it is perfectly safe to say they pay 50% per annum.

The Coburn Trolley Track Manufacturing Co., of Holyoke, Mass., issues a very thorough and attractive circular of their overhead trolley system. The track is of steel and must be very light and durable, and is one of the neatest and enduring in appearance of any track ever placed before the market, and while the figures are not at hand, it surely cannot be very expensive. Their catalogue shows it in various places operated for different purposes, and also shows the trolleys and their construction. This part of their system is especially noteworthy, as when they desire to carry heavier loads, they do not add all the necessary requirements to the weight of the track, but extend the length and add to the number of wheels in their trolleys, spreading the load over a greater area of track.

There is little question as to the cost of such an improvement. The actual value of the thing, the profit it brings, speedily sets the question of first cost aside, and the great consideration is—how much do you need? It is a very difficult question to answer how much money so much track will save, or how many men so much track will supplant. There are places where

$50 worth of track will save the labor of one man constantly. There are other places where it will require four or five hundred dollars' worth of track to save an equal amount, but it is true that wherever anything has to be handled by crane, wheelbarrow, truck or hand, the overhead trolley will speedily pay for itself and prove its value. Put this track over the floor of a molder doing heavy side floor work, and what does it save? First, the man does his own lifting. You save his time and others who would have helped him. Second, he pours off his floor and saves the customary man to help carry off, and last, he shakes out that dirty disagreeable part of the business. You have saved money, time and your man.

Whenever anything has to be moved, it can be accomplished quicker, cheaper and in a more satisfactory manner by this system than any other way.

The writer does not intend in this paper to say anything regarding the details of construction in these systems, but simply desires to show that the ultimate benefit derived from trolley systems in dollars and cents is so great that no concern doing a large or growing business can afford to permit this valuable adjunct to their plant to pass unnoticed.

There was no discussion.

President Schumann: We are honored this morning with the presence of Mr. Tropenas, who feeling somewhat lacking in English idioms has asked Mr. Powell to read his paper.

Mr. Powell then read the following paper by Alexandre Tropenas, on "Notes on the Tropenas Steel Process:"

NOTES ON THE TROPENAS STEEL PROCESS.

By ALEXANDRE TROPENAS.

Several processes for the manufacture of steel, by means of small converters, have been brought forward in recent years; every one of which, according to their inventors, possessed extraordinary advantages. These processes have been tried industrially and have been abandoned because the advantages claimed for them were not always justified, or had been exaggerated, and experience has demonstrated that they could not satisfy the practical requirements of the metallurgical industry. These failures have brought discredit upon all steel processes based upon the use of small converters and have caused many manufacturers to conclude that it is impossible to make good products with such small vessels.

To what causes can the failure of small converters, so far, be attributed? Evidently because these processes did not realize the practical conditions absolutely indispensable to all steel manufacturing processes, viz:

1st. Regularity of working.

2nd. Regularity and absolute control of the quality of steel.

THE TROPENAS PROCESS.

The process we are now introducing and which is the object of this paper, possesses the above mentioned features in the highest degree and these results are not based upon mere experiments, but upon a practical working of over six years.

PLANTS IN OPERATION.

Our first converter, of a capacity of about 800 pounds. was erected in 1891-1892 in the works of Messrs. Edgar Allen & Co., Sheffield, England. The trials made with this experimenting vessel were so satisfactory that after a few weeks the above named firm decided to build a 2-ton converter. The results obtained were exactly those we expected, and since then two other

2-ton converters have been erected. This firm has now three 2-ton converters with which all its castings are exclusively made.

The other plants were then erected in the following successive order:

2nd. Mr. E. Plichon, Paris, France, one 2-ton converter. The same success was obtained as in England. If it were not for the excessive cost of the land, next to this foundry, the plant would be doubled.

3rd. Messrs. Hachette & Driant, St. Dizier, France, one 2-ton converter. This plant has been recently doubled.

4th. Mr. E. Breton, Maromme-les-Rouen, France, one 2-ton converter.

5th. Messrs. Leonard-Giot, Marchiennes-le-Pont, Belgium, two 2-ton converters; quite recently two other 2-ton converters have been erected and the foundry has been increased four times its original size.

6th. Forges & Acieries, Odessa, South Russia, one 2-ton converter was erected at first; two others of same capacity have been added.

7th. Usines Nevsky, St. Petersburg, Russia, two 2-ton converters.

8th. Messrs. Elbertzhagen & Glassner, Mahr-Ostrau, Austria, one 2-ton converter; another of same capacity is now being built.

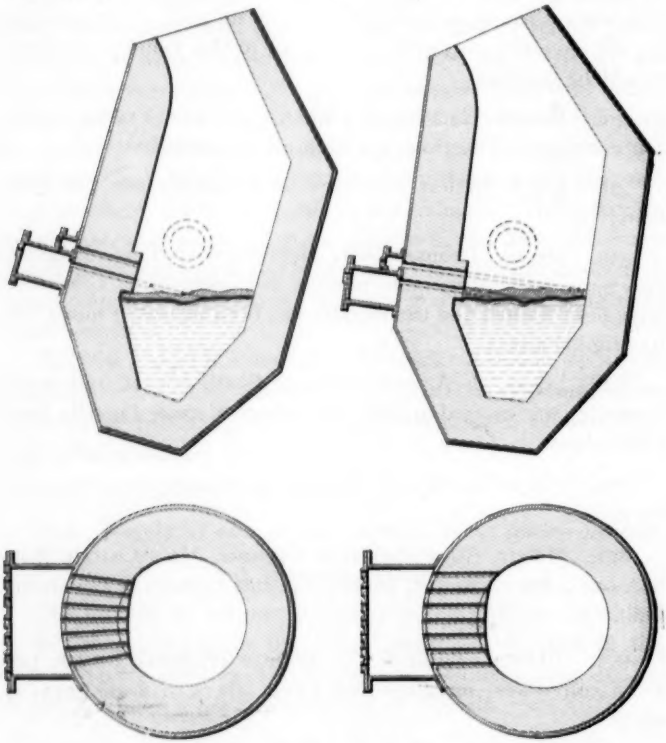
9th. Messrs. Rudski & Co., Warsaw (Poland), Russia, two 1-ton converters; intend to build two others of 2-ton capacity each.

10th. Usine Krautheim, Chemnitz (Altendorf), Germany, two 2-ton converters.

11th. Mr. G. Fischer, Schaffausen, Switzerland, one 1-ton and one 2-ton converters.

12th. Usine de Constructions Mecaniques, Kiew, South Russia, two 1-ton converters.

13th. The Royal Woolwich Arsenal, Woolwich, England. This plant was started with two 2-ton converters and six months later another one was erected. These three 2-ton converters have replaced three Siemens-Martin furnaces, which have been torn down.



TROPENAS CONVERTERS.—SECTIONAL VIEW, SHOWING TUYERE ARRANGEMENT.

14th. Driggs-Seabury Gun & Ammunition Co., Derby, Conn. (U. S. A.), now ready to start, one 2-ton converter.

15th. The Yorkshire & Lincolnshire, R. R., England, two 2-ton converters, in course of erection.

The above list of installations shows that our process has been applied in several countries, where the raw materials and the working conditions are quite different.

PRODUCTS MANUFACTURED.

In all these works the plants have been used for manufacturing steel castings and some ingots also have been made. Every plant has been a success financially and technically.

All the above firms produce castings for their respective governments and for prominent railways. They find no difficulty in fulfilling the requirements called for in the specifications.

The foregoing enables us to assert, without the slightest apprehension, that our process has proved itself to be practical.

THE PLANT.

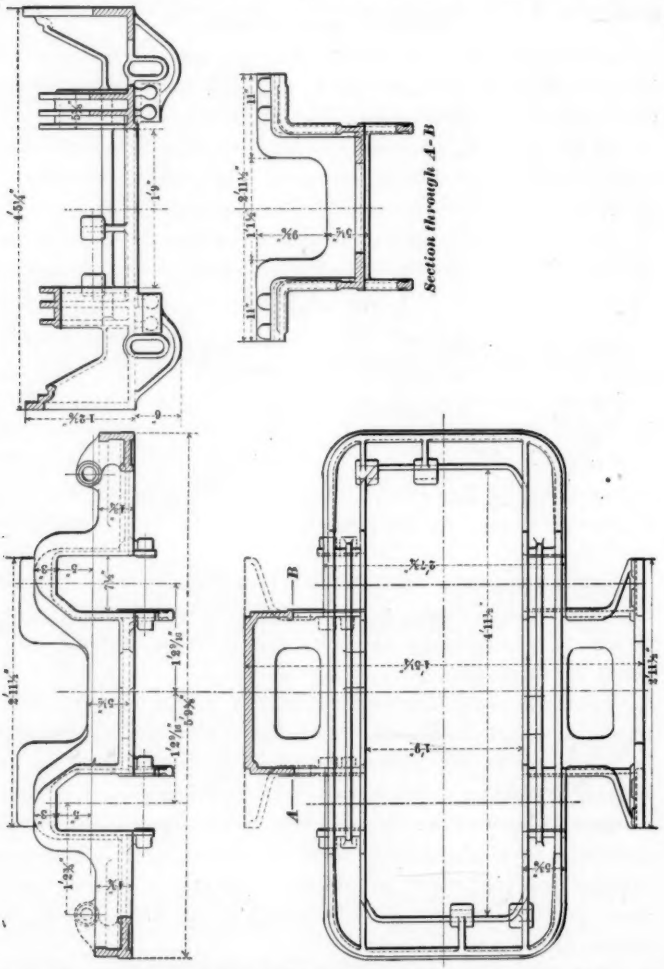
The Tropenas process consists in the use of a special converter, in which the pig iron, melted beforehand, is treated and converted into steel. This vessel, like all other converters, is a sheet steel shell, lined inside with refractory bricks or ganister. The shell is fitted with two hollow trunnions carried on two pedestals, so that the apparatus may be tilted according to the requirements of the operation, i. e., charging the melted pig iron, pouring the steel, etc.

The inside of the converter is so arranged that the metallic bath has a much greater depth or thickness than in all the other pneumatic processes. It is conical for small charges and cylindrical for large ones.

Upon one of the faces of the converter, and in a plane parallel to the axis of the trunnions, are fixed two wind boxes, connected by a conduit to the hollow trunnion communicating with the blowing apparatus. These two wind boxes are entirely independent of each other. Inside of the lower wind box a row of horizontal tuyeres terminate; these tuyeres are large in diameter, varying from 1¼" to 2", according to the size of the converter; they open into the vessel high enough to be always above the surface of the metallic bath.

In the upper wind box a second row of tuyeres is placed; they are flattened and their free section is equal to about ⅔ of that of

the lower tuyeres. This row of tuyeres is placed above the lower row, the distance varying from 4″ to 7″, according to the capacity of the converter. The upper wind box is connected to the



SOME CASTINGS MADE BY THE TROPENAS STEEL PROCESS.—PART OF A GUN CARRIAGE FOR WOOLWICH ARSENAL.

air main by an independent pipe, fitted with a valve, allowing to regulate, at will, the flow of air discharged by the top tuyeres or to suppress it entirely. Lastly, in the horizontal plane, all the tuyeres are so placed that they cannot communicate any gyratory motion to the metallic bath.

THE OPERATION.

When the melted pig iron has been run into the converter, the latter is turned up in such a manner as to bring the lower tuyeres near the metallic bath, but always above it. The top tuyeres air valve is now closed. Then blowing is commenced in this position until the carbon flame appears. When the operation is well under way, the top tuyeres valve is opened so as to admit through these tuyeres a supplementary quantity of air, which penetrates into the converter at a certain height above the metallic bath. This air meets the gases escaping from the metallic bath, and burns them, thus producing a zone of high temperature, which, by radiation, considerably increases the heat of the charge.

The operation is stopped when the flame disappears—this corresponds to extra soft steel. Re-carbonization is then made in the converter by means of a final addition, accurately weighed, thus allowing to produce exactly the hardness and quality of steel required.

THE BLAST PRESSURE.

The blast pressure required for good working varies between three (3) and four (4) pounds per square inch, according to the kind of pig iron treated. The blast can be produced by means of a blowing engine or by a rotary positive pressure blower, such as Roots', for instance.

CHARACTERISTICS OF THE PROCESS.

By what we have said above, it is apparent that the characteristic features of the Tropenas process, are the following:

1st. Low pressure blast, always above the surface of the metal and through the lower or "fining tuyeres."

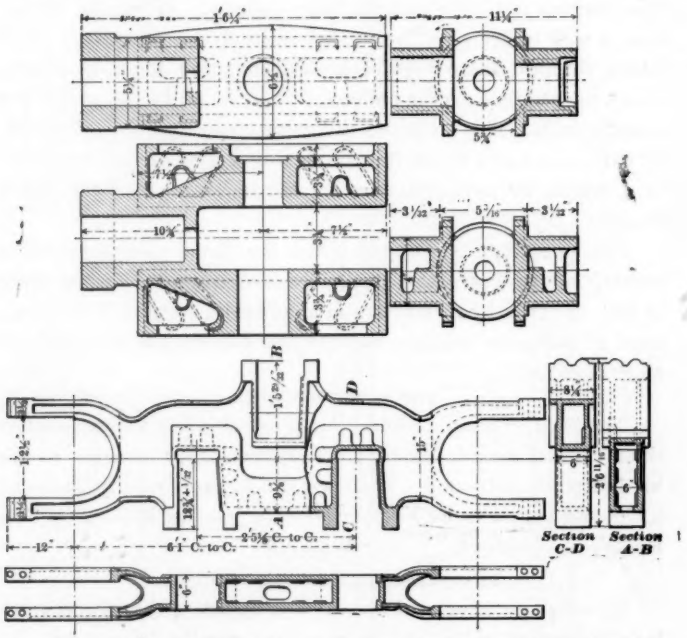
2nd. Disposition of the tuyeres in the horizontal plane so that the jets of air, arriving above the bath, cannot impart to the latter any gyratory motion whatever.

3rd. Great depth of the metallic bath so as to avoid churning and stirring during the operation.

4th. Arrangement above the "fining tuyeres," and independent of the latter, of a supplementary row of "combustion tuyeres," so as to burn the combustible gases escaping from the metallic bath and thus increasing the final heat of the steel.

SURFACE BLOWING AND RESULTS.

Objection has been made to surface blowing on the ground that a greater quantity of iron is burnt than with bottom blowing as in the Bessemer vessel.



SOME INTRICATE CASTINGS MADE BY THE TROPENAS STEEL PROCESS.

This is true in a degree. During a certain period of the operation we have a little more red-brown smoke than in the Bessemer operation, but the loss of iron resulting does not exceed from 1 to 1½ per cent. These data are the result of several years

practice and of a very great number of operations. The low pressure of the blast greatly attenuates this loss, which, evidently, would be much greater if we made use of the high pressure necessary with the Bessemer process. However, acknowledging this loss, it is easy to account for it when making out the cost price.

On the other hand blowing above the surface gives a much better quality of steel than the other pneumatic processes, which blow from the bottom or more or less below the surface of the metallic bath. During the whole time of the Tropenas operation, the bath remains perfectly quiet, and this is entirely different from all the other processes in which a continuous mixture of metal scoria and air takes place. The steel produced by our process is purer and contains hardly any gas in dissolution. The operation being particularly quiet, there is no projection of steel, or very little, through the neck of the converter, contrarily to what occurs in the Bessemer, hence the saving of metal, on this score compensates for the loss of from 1 to 1½ per cent due to the greater oxidation of iron resulting from blowing upon the surface.

ACTION OF THE TOP TUYERES.

By the use of the top tuyeres, the carbonic oxide gas (C. O.) arising from the metallic bath is transformed into carbonic acid gas (C. O^2.), thus greatly increasing the temperature of the final steel without increasing the cost price. This is accomplished by merely burning, in a practical manner, the gases, which all the other processes discharge, without utilizing, into the atmosphere.

The steel obtained being hotter and consequently more fluid allows the gases to escape more easily and when the metal is poured into the molds it is perfectly quiet. Owing to its high temperature and consequent great fluidity the pouring is much easier and the steel produced is better utilized, as no skull remains at the bottom of the ladles.

QUALITY OF METAL PRODUCED.

At the end of the Tropenas operation, before any final addition is made, the product obtained is practically pure iron. This enables us to produce currently a very large number of steel

castings for dynamos and other similar uses, possessing a very great magnetic permeability and which, when analyzed, show from 99.75 to 99.80 per cent of pure iron. These pieces are particularly sound and when machined show no blowholes or similar defects. This is most assuredly an indication of the great purity of the Tropenas metal.

It is easy to understand that the Tropenas metal, produced in such a state of great purity and at such a high temperature, enables us to make the most varied final additions with the view of producing different qualities of steel, from the softest to the hardest and all the intermediate grades; this being obtained by merely modifying the final addition according to the product required.

REGULARITY OF THE METAL.

It is necessary to observe that, though the metallic bath is practically quiet during the operation, the reactions caused by the "fining" blast, are quite sufficient to secure a perfect homogeneity of the charge. This is clearly demonstrated when we pour a 2-ton heat into hand ladles for manufacturing small pieces. The steel from the first to the last ladle is absolutely the same.

WORKING OF THE APPARATUS.

The working of the Tropenas converter is not difficult. It requires, of course, some knowledge, but any intelligent foreman can be taught in a few weeks how to work the apparatus.

Practice has shown that the products obtained are very regular and the signs of the operation are so clear that it is very easy to stop it at the proper time without the use of the spectroscope, because the metal is then completely decarbonized and contains but very small quantities of the elements originally held in the pig iron. The bath, at the end of the operation, being merely liquid iron, practically pure, it is a very easy matter to add a known quantity of final addition to obtain exactly the hardness and quality wanted.

WASTE OF METAL.

The waste of metal during the operation has been the object of special researches. The average, taken from a great number of operations, shows that the loss at the cupola varies between 5

and 6½ per cent. The waste at the converter, during the blow, varies between 10 and 12½ per cent. The average total loss in the cupola and converter is therefore about 17 per cent.

This loss is in no way excessive, when it is considered that it applies to small converters and that the pig iron generally used for manufacturing steel castings, contains from two and one-half to three and one-half per cent of silicon.

PIG IRON USED.

The pig iron, usually employed by us for manufacturing steel castings, has the following analysis:

Silicon	from 2.50 to 3.50 per cent
Manganese	from 0.50 to 1.25 per cent
Carbon	from 3.00 to 4.50 per cent
Sulphur	from 0.03 to 0.06 per cent
Phosphorus	from 0.04 to 0.07 per cent

With pig iron of such a composition, the mechanical results obtained on test bars, cut off from castings and not forged, have given the results shown in the tables, A, B, & C, annexed.

It is necessary to mention that the more the pig iron is free from sulphur and phosphorus, the better the results. However, when the results required are merely those needed for the navies and railroads, ordinary Bessemer pig iron, containing not over S. 0.06 and Ph. 0. 07 can be used.

When the steel produced is to be submitted to particularly severe tests, it is better to use a pig iron as devoid as possible from sulphur and phosphorus.

SANDS REQUIRED.

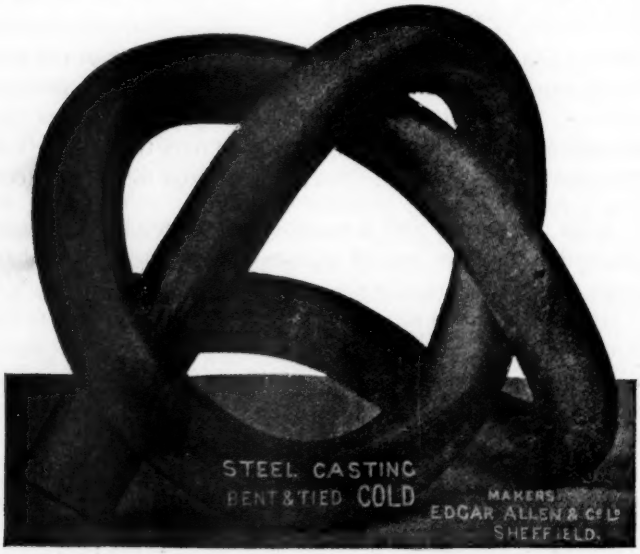
The sands necessary for making molds are silicious sands containing a sufficient proportion of alumina to give the molds the required hardness. We do not give any analysis because we have generally found suitable natural sands in all the countries where we have erected our steel plants. Anyhow, it is possible to obtain what is required by a judicious mixture of the different kinds of sands available.

MOLDS.

All machinery castings having to be machined upon several faces, must be cast in dried molds, also large castings with great thicknesses.

Less important castings for which slight defects, such as pin holes, slight scales, etc., are not a sine qua non condition, are cast in green sand molds not dried.

In the majority of foundries, using our process, a great proportion of the castings are cast in green sand molds not dried



SAMPLE OF METAL MADE BY THE TROPENAS STEEL PROCESS.

or merely skin dried. The greater part of the small castings are cast in the same manner.

REHEATING.

When the castings are taken out of the molds, it is not indispensable to reheat them.

The steel as it comes from the converter is perfectly soft and malleable. The great majority of castings delivered to the trade

are neither reheated nor annealed. When pieces, however, have great or uneven thicknesses, or when they are of a great bulk, it is preferable to reheat them for a few hours at a cherry red heat in an ordinary furnace, without the use of any iron ore or other recarbonizing elements. The object of such a reheating is simply to transform the crystalline structure of pieces, having great thicknesses, into a finer grain, or to relieve the molecular tensions due to the considerable shrinkage of steel when the castings have a great bulk.

Reheating is also necessary when high mechanical results are to be obtained and principally when a great elongation is required.

APPARATUS REQUIRED.

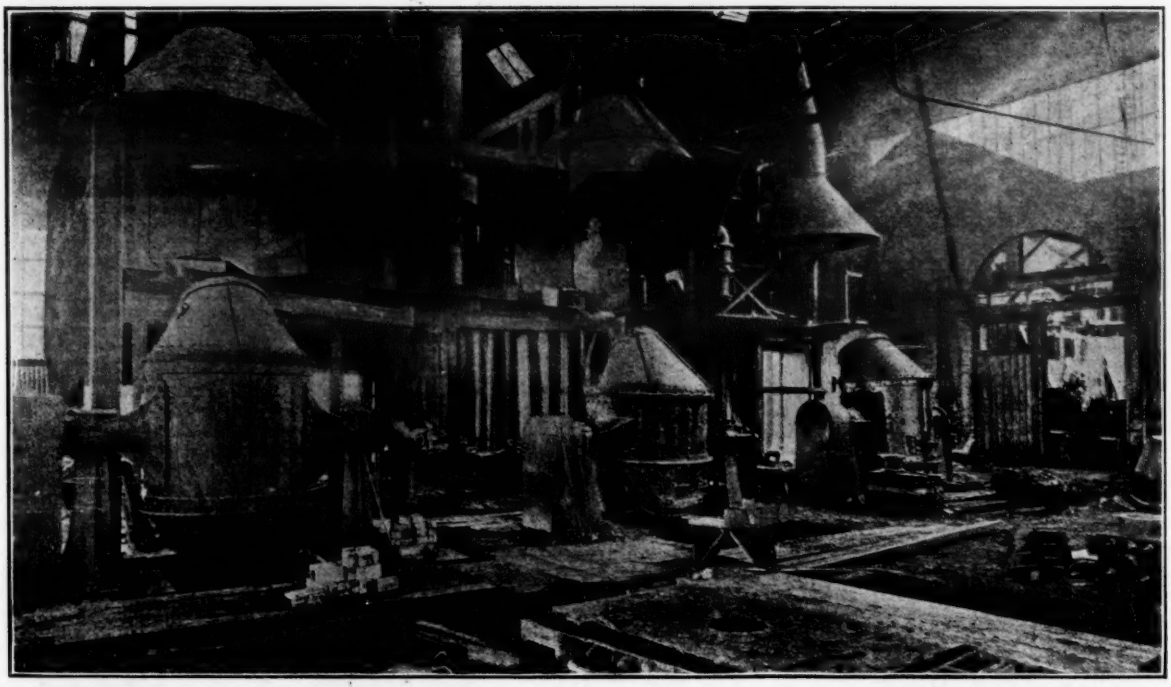
The installation of the steel process proper requires first, one or several converters according to the quantity of steel to be produced. Each converter works in connection with a cupola, the latter is generally placed upon a metallic platform, high enough to allow the melted pig iron to run direct from the cupola into the converter. The cupola is operated in the usual manner by means of a fan or a positive pressure blower.

The air blast for the converter can be produced by means of a rotary positive pressure blower, the air pressure being only from 3 to 4 pounds per square inch. The quantity of compressed air required is from 22 to 25 cubic meters per minute (776 to 883 cubic feet) per ton of pig iron to be treated.

The expenditure necessary for a plant consisting of two 1-ton converters, 2 cupolas and their platforms, fans and rotary positive pressure blower is about $6,500, erection included.

The cost of two 2-ton converters, 2 cupolas, platforms, fans and blower is about $8,500, erection included.

To this must be added the cost of a crucible furnace for final additions, which we generally add in a melted state. The expenditure for such a furnace is a small one, and does not exceed from $150.00 to $200.00. Besides the steel producing plant proper the usual foundry apparatus are necessary, such as flasks, ladles, tumblers, reheating furnace, ovens for drying cores, molds and hand ladles, sand crushers and mixer, forges for smithy, tools for cutting headers, cranes, etc.



TROPENAS PLANT AT THE WORKS OF MESSRS. EDGAR ALLEN & CO., LTD., SHEFFIELD, ENGLAND.

DURATION OF THE OPERATION.

Each operation in the converter lasts from 15 to 20 minutes; some time is required for pouring the steel into the molds and for preparing the converter for another blow. We reckon when small pieces are manufactured and the whole charge has to be poured by means of hand ladles, that 40 minutes are necessary for a complete operation. When the pouring is made with large ladles it requires only 30 minutes. In the first case 3 operations can be made every 2 hours, and 4 operations in the second case. With such data it is easy to calculate what quantity of steel can be produced when working nine hours per day.

LININGS AND TUYERES.

The converter lining lasts from 125 to 150 operations; the tuyeres from 30 to 40 operations, after which the latter must be replaced. While this is being done the necessary patching up of the lining is made according to requirements. If some holes have been formed, they can be plugged by means of a mixture of cement and brick.

The linings are made with silica bricks, the cement being composed of quartz, sand and clay.

COST OF STEEL.

The cost of producing the steel varies from $5.00 to $6.00 per ton of 2,200 lbs. over and above the cost of pig iron, this includes all expenses incurred at the blowing apparatus, cupolas, labor, lining, tuyeres and all general expenses for the manufacture of the steel in the ladle, ready to pour. These prices are the result of the accounts of works in normal operation for several years and in which the yearly output is about 2,500 tons. With a greater production the cost is reduced.

ADVANTAGES OF THE PROCESS OVER OPEN HEARTH.

The advantages our process offers, when compared to the Siemens-Martin process, or Open Hearth, are very important, when castings of all kinds, small, average and large, are to be manufactured in the same foundry.

It is impossible to make small pieces with open hearth steel, it is not hot enough, and a great quantity of the material is lost in the ladles by skull, etc. Our steel being very hot and very

liquid, it is easy to cast all kinds of small pieces, very thin and this is done without loss of metal. The open hearth is not well adapted either for manufacturing average pieces for the same reasons as for making small castings.

Our process, on the contrary, is perfectly suited for all these requirements, because of the great advantage it offers of being able to take from the converter small quantities of steel, exactly what is required for filling mold, then to tap the vessel again for the quantity of steel necessary for another casting and so on. We admit the superiority of the open hearth over our process only when very large pieces are manufactured continuously to the exclusion of average or small castings, but it cannot be denied that this is not usually the case with steel foundries. With our process we can, without any inconvenience whatever, cast very large pieces in a practical manner and still remain well adapted for producing average and small castings. We very often run in the same ladle 3, 4 and 5 successive melts and use the total metal to cast one piece, and this we do without any loss of material from ladle bottom skull, etc. Our steel is so hot and so fluid that it can be kept very long in a ladle without becoming pasty.

The open hearth, to be worked economically, must be run continuously night and day, for if it is worked by day only, the heat must be kept up during the night and this is necessarily accompanied by a great expense in labor and gas. With our process, when the pouring is finished everything is stopped and all expenses of labor and fuel are suppressed until steel is again wanted. Our process also adapts itself better than the open hearth to fluctuations in orders, it is, without possible discussion, much more elastic. According to requirements five or six operations, or even less, can be made in one day or twenty-five if necessary. The open hearth, on the contrary, is not elastic at all, for it produces regularly the quantity of metal corresponding to its capacity, but the production can be neither increased nor decreased to any great extent.

Lastly each operation of the Siemens-Martin process being of the total capacity of the hearth, say from 8 to 10 tons, for

instance, it becomes necessary to dispose of a large molding floor space, so as to distribute the quantity of molds corresponding to the weight of metal to be poured at one cast. With our process, on the contrary, we have a smaller charge to pour every thirty or forty minutes, and, in such conditions, it is much easier to distribute the work without interfering with the foundry operation, which keeps going on as if pouring were not taking place.

Lastly with our process we can re-use all our scraps, that is, runners, gate-ways, headers, etc., and this is done as easily as in the open hearth, and, probably, more completely.

So far as the quality of steel is concerned, our products are superior to those of the Siemens-Martin furnace. We have, already, replaced several open hearth furnaces by our process, specially at the Royal Woolwich Arsenal, and the manufacturers who have made such a change declare that they are entirely satisfied on all points of view. We can also, with our process, produce, outside of castings, several high grades of steel that the open hearth cannot produce.

BLOW HOLES.

So far as blow holes are concerned, we can say that our products are free from such defects, when the molds are well made and dried. A very great number of our castings are machined and are found absolutely sound.

PRESENT PRODUCTION.

We are now producing, in our works, about 30,000 tons of steel castings per annum, and the marked favor with which they have been adopted everywhere shows that they give satisfaction to all the industrial requirements.

WELDING PROPERTIES.

Lastly our castings of ordinary soft quality weld as easily as iron, and they can be welded together or to iron exactly as the best soft steels produced, so far, by the basic processes.

RESUME.

The process we are now introducing in the United States offers all the guarantees of success desirable for the manufacture of steel castings.

So far as cost is concerned it compares advantageously with the Siemens-Martin process.

So far as the quality is concerned the results are equal to those obtained by the best crucible steel, and we can reproduce with safety any specified quality, as often as may be desired. The steel is of a regular quality.

SAMPLE OF METAL MADE BY THE TROPENAS STEEL PROCESS.

The process adapts itself remarkably well to all fluctuations in orders, as without any difficulty whatever a small or a large production can be attained, and reversely so, without any useless expenditure.

We do not pretend to take completely the place of the present processes, but we sincerely believe that in foundries having open

hearth furnaces, our process would perhaps be a powerful adjunct allowing to manufacture, in better conditions of cost and quality, a great number of pieces for which the latter is not well adapted, such as small and average pieces, leaving exclusively the use of the hearth for heavy castings.

In foundries having no Siemens-Martin furnace or for those to be erected, our process will enable founders to manufacture all kinds of castings, from the smallest to the heaviest without the necessity of erecting such furnaces.

We believe that the use of our process, in this country, will also greatly increase the field for steel castings by making it possible to manufacture pieces which, so far, have not been made by the processes now in use.

A.

ORDINARY STEEL CASTINGS FOR MARINE AND LOCOMOTIVE ENGINES, HYDRAULIC, MINING, AGRICULTURAL AND OTHER MACHINERY.

Distance between gauge points.	Tensile strength per sq. in. lbs.	Elongation per cent.	Reduction of area per cent.	Designation of castings from which test-bars were taken.
2 inches	61,824	35.5	54.8	
2 "	64,691	34.0	52.4	
2 "	66,124	32.5	52.4	
2 "	62,003	34.0	52.4	
3 "	61,824	31.3	49.6	
8 "	60,838	24.8	52.4	
2 "	66,396	35.0	54.8	Under Admiralty inspection.
2 "	62,720	33.0	52.4	
2 "	74,009	30.0	52.4	
2 "	72,396	35.0	50.8	
2 "	73,292	33 0	54.8	
2 "	71,411	32.5	52.4	Cross heads.
2 "	63,257	35.5	54.8	Boggie frame centers.
2 "	70.873	33.0	52.4	Boiler roof bars.
2 "	69,798	33.0	54.8	Hornblocks.
2 "	72,352	35.0	50.8	Locomotive wheel center, 6 ft. 6 in. D.
2 "	71,635	34.0	56.5	Coupling hook.
		UNDER ADMIRALTY INSPECTION.		
2 "	73,561	33.0	52.4	
2 "	65,766	33.5	54.8)	Packing ring for 6-in. rapid firing
2 "	66,124	36.0	52.4)	guns H. M. S. Caesar, Illustrious, etc.
2 "	69,350	33.5	54.8	Mast cap casting.
2 "	71,635	34.0		Average of 113 tests for Belleville boilers.
2 "	68,364	35.5		Packing ring H. M. S. Andromeda.
2 "	68,185	35.5		Twisted and tied cold.

B.

UNDER ADMIRALTY INSPECTION.

Tensile strength per sq. in. lbs.	Elongation per cent.	Reduction of area per cent.	Designation of Castings.
74,502	(in 1"-48.0 in 5"-29.2) (in 2"-38.5 in 6"-27.8) (in 3"-34.0 in 8"-25.9) (in 4"-31.0 in 10"-23.8) (in 1"-44.0 in 5"-28.0)	43.4	Engine frame castings for H. M. S. Proserpine.
71,187	(in 2"-36.0 in 6"-26.5) (in 3"-32.3 in 8"-24.3) (in 4"-30.0 in 10"-22.6) (in 1"-58.0 in 5"-32-2)	35.6	
61,600	(in 2"-43.0 in 6"-30.2) (in 3"-37.3 in 8"-28.1) (in 4"-34.3 in 10"-26.2)	50.8	

c.

COMPRESSION TESTS.

HEIGHT OF PIECE BEFORE 0".500; DIAMETER, 0".500.

Tensile strength per sq. in. lbs.	Elongation on 2-in. per cent.	Reduction of area per cent.	Elastic stress per sq. in. lbs.	Maximum stress per sq. in. lbs.	Height after test, inches.	Total compression.
111,193	10.0	8.4	53,020	487,648	0.198	0.302 (a)
79,900	30.5	46.6	41,820	545,888	0.157	0.343 (b)
64,960	36.0	54.8	32,681	571,428	0.140	0.360 (c)
83,059	26.0	30.8	34,742	510,048	0.165	0.335 (d)

Notes.—(a) Barrelled, slightly fractured, no appearance of fracture when compressed 50 per cent of its original height.
(b) Same as (a)
(c) Same as (a) and (b) but very slightly fractured.
(d) Same as (a) and (b).

ELASTIC STRESS TESTS—TEST PIECE d=0.564.

Elastic stress per sq. in. lbs.	Ratio of elastic to maximum stress per cent.	Maximum stress per sq. in. lbs.	Elongation in 2 in., per cent.	Reduction of area per cent.	Designation of piece.
27,596	41.3	66,752	35.5	54.8	Belleville boiler castings
28,761	41.5	69,350	31.5	47.2	"
26,257	41.5	64,646	34.5	54.1	"
26,432	40.6	64,960	33.0	52.4	"
26,432	41.1	64,153	35.0	52.4	"
26,432	40.4	65,408	35.5	52.4	"

TESTS MADE IN THE UNITED STATES.

Distance between gauge points.	Tensile strength per sq. in. lbs.	Elongation per cent.	Reduction of area, per cent.
2 inches	65,480	35.0	41.0 (a)
2 "	64,850	37.5	50.0 (b)
2 "	72,080	35.0	54.5 (c)
2 "	56,726	27.0	28.7 (d)
2 "	54,033	38.9	55.1 (e)
2 "	139,000	10.0	.... (f)
2 "	103,000	16.0	.... (g)

(a) Annealed; 75 per cent. frac ture crystalline, 25 per cent. silky. (b) Double annealed; fracture silky. (c) Annealed and forged; fracture silky. (d) Not annealed. (e) Same piece as d annealed for 5 to 6 hours in full fire (10 hours total operation). (f) and (g) Projectile steel.

Mr. Gates: I think every foundryman realizes that steel is going to take a larger place in the manufacture of machinery and work of that class, and it seems to me that any effort that is made in that direction of a converter which will allow of its being introduced into the foundry is a good step and we should encourage it.

Dr. Moldenke: What is the percentage of loss in the metal?

Mr. Powell: It is mentioned in the paper.

Mr. Tropenas: It is from four to six and a half per cent at the cupola, according to the composition of the pig iron used. We have, of course, a loss in the converter, and it varies more or less with the percentage of silicon and other elements contained in the iron. Our experience has shown that a loss in the converter and cupola together varies from fourteen to seventeen per cent, according to the kind of pig iron used and kind of steel manufactured. These data are not the result of one or two blows, but of thousands of blows. If hard steel is to be made from a specified iron, that is to say, if you stop the blow before all the carbon has been removed, you will have less loss than if you make a soft steel. We have had very little experience yet with the process in the United States. We started last week and made two charges of a hard grade of steel for government purposes. We took a few test pieces from the first blow, and they showed that the tensile strength was, in one case, 103,000 lbs., with an elongation of 16 per cent, and in the second case was 107,000 lbs., with an elongation of 9 per cent. These, of course, not having made any selection of iron, constitute a very good test. In Europe we are making a lot of castings for government purposes, and in every case the pieces, or a great many of them, have to be tested by test pieces cut off the casting, and they turn out very satisfactory.

Mr. Bailey: What is the loss in charging the cupola, from the metal to the converter?

Mr. Tropenas: About 14 per cent to 17 per cent.

Mr. Bailey: Do you put all the scrap in the cupola?

Mr. Tropenas: Yes, we melt it all.

Mr. Bailey: What percentage of loss do you reckon on making a steel casting?

Mr. Tropenas: The proportion of scrap, such as risers, gates, etc., generally depends on the class of castings to be made. Generally speaking, for ordinary work an average of 25 per cent is practically correct.

Mr. Bailey: Is it expensive to melt scrap in the cupola?

Mr. Tropenas: No, it is not. Of course, the scrap is harder to melt than the iron, but you get some carbon from the coke in the cupola and it allows you to get the necessary heat.

Dr. Moldenke: When you blow down to the end of the operation is there not a danger of oxidization?

Mr. Tropenas: Yes. But the precautions to be taken to avoid this are very simple. We have very little gas, owing to the blowing above the surface. The steel is perfectly free from gases, and it would strike you to see how we pour into the mold. We treat it in the same way as one would for cast iron. Two or three men go to the converter, tap it, and go about the foundry pouring the charge, and come back with a little steel possibly remaining in the ladle, but they run a little more metal on top of it, just as with ordinary cast iron. We can make a vast number of our small castings in green sand.

Mr. Schumann: Is this method at all applicable to foundry purposes?

Mr. Tropenas: Yes, for steel founders.

Mr. Schumann: I mean for ordinary foundry castings of gray iron?

Mr. Tropenas: In some cases we have made castings which I could hardly call steel castings or iron castings, they were between the two.

Mr. Schumann: I mention that because all thoughtful foundrymen realize the fact that we eventually must produce a steel rather than an iron casting. There is no reason why we should continue in cast iron when we can get a machinery metal easily

machined and with more ductility. Remarks have been made years ago that it should be expected within a reasonable time that our product from the cupola would be entirely different from what it is to-day. And if the method or process of Mr. Tropenas would produce a fluid material which would be as readily manipulated in the sand mold, whether green or dry, it would be a great step in that direction, and I would request Mr. Tropenas to give his views as to this.

Mr. Tropenas: I cannot say that we have had a great deal of experience about it. In some cases we have been asked to make castings which are not exactly steel nor iron. We could not expect a great deal of elongation from such castings. What we wanted was rather a high tensile strength. In this case I cannot give the capability of it, because we have not gone far in that direction. It is possible, if you take away all the silicon and manganese and part of the carbon, you can reach many grades of metal which cannot be called steel nor iron. I repeat that I have not had enough experience in that direction. I have principally made real steel castings.

Dr. Moldenke: I think the President wants to get something better than air refined iron, but it will be found difficult to strike the right carbon.

Mr. Tropenas: Yes, that would be the practical difficulty. It could be overcome, but it is hard to do so. What makes our process regular is that in many cases we blow the operation out to the end, then add a certain definite quantity of carbon in, and we know exactly what we are going to produce.

Mr. Bailey: What is the largest blow you have found practicable?

Mr. Tropenas: Well, we can blow up to 10 tons if we like. But our system has been applied so far to small converters only, one and two tons capacity.

Mr. Bailey: Why do you prefer the small converter?

Mr. Tropenas: Because small and moderate charges are better suited to foundry practice, they are handier and more elastic.

We can work a 10 ton charge as economically as a one ton charge if occasion requires such a large amount.

Mr. West: In regard to the quality of this metal. We know that as a rule in making steel castings, there has been a great deal of labor and experiment to bring them up to their present state of perfection. In peeling a steel casting, removing sand, etc., in ordinary iron practice we do that very readily. How would this metal of yours compare with the present steel work and iron also?

Mr. Tropenas: A good deal depends on the quality of the steel and the nature of the sand used. Originally we used the sand as it came from the quarry, without mixing it. We find the proper sand in all countries. It is silica sand containing 80 to 90 per cent of silica, 4 per cent to 6 per cent of alumina, some oxide of iron, some lime and a few other elements. While this sand is a silica sand and carries a certain proportion of alumina, it has a body to it, and when we get such a sand the casting is pretty smooth on the exterior surface. But we find difficulty in removing the sand from the core. When the contraction of the metal recedes some from the sand then the surface is pretty smooth. We make special mixtures of sand for cores. We generally use a sand blast for cleaning.

Mr. West: Then you have the same difficulty as arrived at with ordinary steel castings. In regard to the shrinkage and contraction of your castings, how is it in that regard in relation to the present steel castings? Have you lesser or greater shrinkage?

Mr. Tropenas. About the same. The shrinkage is greater in small castings when the steel is cast hot. When we cast heavy castings we do not cast so hot.

Mr. West: There are two factors taking part. The question of shrinkage, I mean the action taking place in the metal when cooling down. Then we have contraction going on after that which decreases the size of the casting a little. In making all steel castings there is a great deal of trouble found in overcom-

ing both these. They have to put sinking heads on to take charge of shrinkage, and allow in the molds spaces to allow the casting to come in.

Mr. Tropenas: Exactly the same conditions apply.

Mr. Bailey: In making the soft steel castings you, of course, eliminate the carbon, manganese and silicon. Here is a mixture of iron you use. The figures you give us do not allow anything for burning of the iron in the cupola.

Mr. Tropenas: You have about 6 per cent to 9 per cent of foreign material. When you eliminate all these elements you have besides a loss of iron, and the total loss, foreign elements and iron included, is about 14 to 17 per cent.

Mr. Bailey: It all costs money, whichever way you look at it.

Mr. Tropenas: We say exactly what we find. We put down 17 per cent of loss. This is the maximum. I do not wish to give data too nicely, I put it in the extreme. Very often we have less than 14 per cent altogether.

Mr. West: I should like some idea as to the practical operation of the work, as to utilizing it in the foundry ordinarily. Could our cupolas for melting iron be used for your process and all that would be necessary in addition be a converter?

Mr. Tropenas: Yes. Generally speaking, however, we prefer to place the cupola on a stage and run the metal direct into the converter by gravity. If we place the cupola on the ground, then we have to run the melted pig into the ladle, take it up by means of a crane and pour into the converter.

Dr. Moldenke: How do you make your additions?

Mr. Tropenas: We melt in crucibles or a small cupola.

Dr. Moldenke: I want to put a question which you may not like to answer. It may happen that people have 10 ton furnaces for open hearth work and would like to compare the expense of that work with your process. Can you give figures on that?

Mr. Tropenas: It is hard to do that, not having had any experience in this country. In the course of a week or two I may

know something more. Next year I hope to have a few works in operation and can then give you figures. I do not like to give figures when I am not certain.

Mr. Bailey: What advantage do you claim for your process over the old Clapp, Griffiths and Robert processes?

Mr. Tropenas: I do not know very much about them, but I think the latter is the best. The other in some cases gives very good and hot steel, but you never know when it is going to be good or bad. The tuyeres placed 3″ below the surface of the metal is not new. It is more or less the Bessemer process. In the Bessemer you blow from the bottom, but you mix slag, metal and air, and if you blow from the side a certain distance below the surface of the bath it is practically the same, slag, metal and air are mixed together. When you have to make a casting you must have a hot blow, if the metal is cold it is impossible to pour properly and the castings are not sound. We claim that with our system of tuyeres we can bring the temperature to a high degree. We have a plant at Derby, Conn., which we started last week, where we are now making some projectiles for your government. I must say we have to make a very special steel to stand a very strong test. We have only so far made two blows The result shows that it will be satisfactory and that we can meet the requirements of the United States Government.

Mr. Guy Johnson: I should like to know why you use a cupola to start this process? Whether it would not facilitate the work to use an air furnace and get the metal down to a much higher degree of purity before pouring? Some people melt large quantities in an air furnace and the product is much purer.

Mr. Tropenas: You mean we could take the carbon off. I do not see the necessity for it, because in our converter we can remove all those impurities, and besides that, while removing them we are raising the temperature, and we want it. If we should start the blow with metal having, say one-half of the impurities, we should not perhaps get the proper temperature at the end. We claim that with our process and with a given analysis

of pig iron we reach the temperature wanted at the end. If we had nothing we could not do it. If we remove the carbon, how are we going to have our inside gas?

A Delegate: I understood you to say that by your process you can cast from green sand molds. How does the surface of such castings compare with the surface of castings cast in dry molds?

Mr. Tropenas: There is no great difference between the green sand casting and the dry sand one. There is a slight difference in favor of the dry sand mold, but it does not depend much on the kind of mold; but depends more on the analysis of the sand. We make a great many green sand castings for mining and quarry car wheels.

The Chairman: It is a question of the diffusion of the two metals.

The Delegate: I understood when a casting was to be finished it should be cast in a dry sand mold.

Mr. Tropenas: In some cases we make allowances.

The Chairman: I thank you very heartily, Mr. Tropenas, on behalf of our members for your presence, and I only hope you can succeed in furnishing the foundrymen with a metal having the minimum of contraction and the maximum of strength and ductility, and we will proceed to make shells for our naval vessels.

Mr. Tropenas: I expect that before long we shall make a special steel with high tensile strength and a good deal of elongation and ductility along with it. This will reduce the weight of a casting materially.

The Chairman: Our object is to get through this morning's session quickly, so the order of business will be slightly changed. The next paper is on "The Manufacture of Steel Castings," by Mr. Johnston. This paper is by Mr. Stewart Johnston. The paper of Mr. Guy R. Johnston will follow.

THE MANUFACTURE OF STEEL CASTINGS.

By STEWART JOHNSTON.

France and Germany both claim to have been the producers of the first steel castings. France certainly made the first marketable open-hearth steel castings as early as 1870 at the Terre Noire Company.

About the year 1861, steel castings were made by the crucible process by the Messrs. Vickers, of Sheffield, England, they operating under Reippe's patent, mention of which is made later.

In this country, prior to 1870, a number of steel works made a few castings, but they were intended for their own use, and little thought was given as to their quality. A few attempts were made during the civil war to produce small field pieces of cast steel.

In 1870, William Hainsworth, a native of England and at that time a resident of Pittsburg, had constructed a small furnace capable of holding two crucibles, and with this small plant he made experiments until his capital was about exhausted. He had, however, been successful in producing a metal with that sonorous ring characteristic of steel, combining, too, the toughness and the malleability requisite. His efforts had been more particularly directed to the manufacture of the cutting parts of agricultural implements, and, with samples of these, he was not long in organizing a company, which was incorporated in March, 1871, at the same time erecting a plant in Pittsburg, which was the first American steel foundry. Up to about 1870 nearly all the steel castings were made by the crucible, or pot, process, including those made by the Vickers in England, as well as those produced on the continent; the molds for which were made by grinding up old clay crucibles, adding to this about 25 per cent of plumbago and a quantity of coal tar with clay wash to give proper temper. This, in short, is the Reippe patent.

Hainsworth in this country used ground coke, mixed with ground plumbago crucibles, German clay and all tempered with glue water, and on this mixture he took out a patent.

The English crucible was made principally of a native clay, while in America the crucible is made of graphite from Ceylon.

It will be observed that the composition of both the domestic and foreign mold contains much carbon, and this always affected the steel inasmuch as the steel drew carbon from the mold, the result being a high carbon metal which was, after casting, hard and brittle. On the annealing furnace much was depended to reduce the casting to proper toughness and softness. It might here be stated that crucible steel castings of to-day are made comparatively soft without annealing by employing a large percentage of wrought iron in the charge, but in the early manufacture of these castings this was not the practice. In the latter part of 1874, Mr. Hainsworth had constructed by this company an open-hearth furnace, which, in 1875, was used in making steel castings, the first open-hearth furnace in this country to be so employed; and, in 1881, Hainsworth made Bessemer steel castings. For those iron foundrymen not familiar with the different ways of making steel, it might be proper to refer briefly to the methods, of which there have been seven employed, namely:

1. The direct method, as the Catalin forge.
2. The Finery.
3. Puddling.
4. Cementation process.
5. Crucible.
6. Bessemer, or pneumatic.
7. Open-hearth.

There are now but the three latter methods used in this country.

Reaumer, a French scientist, born at Rochelle, in 1683, is credited with being the first to employ the crucible in making steel. Huntsman, living in Sheffield, England, during the latter years of Reaumer, greatly developed the process.

The modern crucible furnace is constructed in a rectangular well shape, the top of which is usually at floor level. At either side of the hole, or furnace proper, are two chambers filled with open brick-work called checkers. Gas, generally used as

fuel, is brought through one of these chambers and air through the other, the two uniting at and around the crucibles where the combustion takes place, the waste heat and products of combustion passing out and heating checkers in the two chambers on the other side. At stated intervals the direction of the exit and entrance of the air and gas is reversed. This method, as described, of bringing heated air to support the combustion of the heated gas, is known as Seimen's regenerative process. The top of the hole, or furnace proper, is made in a number of sections, which are removed to admit of putting in, or taking out, the crucible. The charge consists of about one hundred pounds wrought iron, or steel clippings, with proper additions of manganese, silicon, or other ingredients, to insure solidity to the castings. The crucibles, after being filled, are covered with a lid of the same material as the pot, and the "puller out," as is called the furnace helper, by the aid of tongs, lowers them into the furnace. After from three to four hours the mixture is brought to the proper condition, and the "puller out" lifts the pots from the furnace, from whence they are carried to the molds and poured. Furnaces are built to hold from eighteen to thirty-six pots.

In 1856, Sir Henry Bessemer startled the civilized world by announcing that he could produce steel from molten iron without the aid of further fuel. The Bessemer, or pneumatic, process consists of placing molten iron in a converter, an elipsoidal retort, and forcing air through the metal until the iron is decarbonized, as well as reduced in manganese and silicon. In nearly a horizontal position the converter receives the iron from the cupola, the blast is then turned on and enters through one end of the converter, which is then revolved 90 degrees into a nearly vertical position, the molten iron covering the tuyeres through which the blast is being forced. By the action of this blast through the molten metal a high temperature is developed by the combustion and oxidation of carbon, manganese and silicon; the heat thus developed being sufficient to maintain the charge in a state of fluidity. In fact, the temperature increases during

the process until nearing the end. The iron, having been decarbonized, or converted into steel, then has added the speigel and is ready for the ladle, from whence it goes to the molds. The Bessemer process is to-day substantially as first introduced, and unlike it, few inventions are at their inception so nearly perfect as to admit of but little or any improvement. A great number of patents on the method, or place, of introducing the blast have been taken out, and these various methods, or processes, usually bear the patentee's name, but they are but variations of the original idea of Bessemer, to whom due credit must be given.

The open-hearth process is but a development of older forms. The Martin process consisted of melting in an open-hearth furnace wrought iron with pig iron to produce steel; Siemens melted pig iron and iron ore; and these two methods were combined and furnaces constructed on the regenerative plan, to which reference has been made. This, in brief, is the evolution of the Siemens-Martin open-hearth furnace as generally used to-day, and as first used in 1845.

More particularly it may be said that the furnace is usually rectangular in shape, the center and upper portion of which is the hearth proper, which is supported on a structural bed, and beneath it are two pairs of regenerators. The gas under pressure and air are introduced through one set of regenerators, passing up through same, enters the hearth at one end, combustion taking place over the metal charge. The waste products of combustion passing through the other pair of regenerators, the exit of gas and air being reversed at regular intervals. On one side of the furnace are doors through which a charge of pig iron, steel or other scrap, and ore is thrown in to be melted, and on the other side is the tap hole. It will be noticed this process differs from the other two described, in that the flame comes in direct contact with the metal charge.

The first decade of the manufacture of steel castings in this country was not marked by decided advancement. Engineers in the constructive arts criticised and accepted steel castings at first with incredulity, it being urged that lack of uniformity existed,

that many of the castings were machined with great difficulty, and indeed large proportions were rejected for their brittleness and hardness. Another objection militated against castings of the seventies was that they were not homogeneous, hard spots in castings were frequently noticed, not to mention blow holes. These castings, however, filled a long-felt want in supplying pieces that required a hard surface, such as dies and stampers, and parts of agricultural implements, as well as an infinite number of other uses.

Not, however, until in the eighties did the great stride in this branch of metallurgy begin to be noticed, when the manufacture of castings by the open-hearth and Bessemer processes becoming more and more general, the distrust with which the castings were first received became less and less. It was found that steel castings could be procured upon which the engineer had confidence, that the metal was soft and tough as wrought iron, yet greatly surpassing it in strength. Still the appearance of the casting was far from satisfactory; the proper material for a steel mold had not been used. The early steel foundrymen will recall the castings that came from the molds were so incrusted with sand, that the piece when shaken from the flask was with difficulty located, and only after digging away with picks and bars was the outline of the casting discernible. Then followed an expensive process of removing the sand. Annealing was then nearly universal, as in fact much was depended upon the anneal to remove the hard caked sand.

As the improvement in the metal was achieved through the better acquaintance with the requirements and through the aid of chemical research, so it became, after years, to be understood that steel at a temperature of 3,700 to 4,000 degrees F. required a different mold than cast iron at about 2,000 degrees F. A refractory material had to be obtained for the mold capable of withstanding the attack of the highest temperature known in metallurgy, and, although being impervious to the action of the fluid metal and free also from chemical reaction therewith, it must not be so dense as to prohibit the exit of gasses formed.

To Geo. Cowing, of Cleveland, O., is attributed the distinction of first making a mold for steel, much the same as is to-day used, of nearly pure silica, which material is first ground and mixed, and brought to the proper temper and adhesion by addition of glue water, molasses water, or flour water, and when made into a mold is generally faced with silica dust, or quartz ground to an impalpable powder.

After having obtained the right sand mixture, precaution must be taken in ramming well the mold, for steel is so much more trying on it than iron that if this be lost sight of in the molding, scabbing can be expected, and can only be prevented by hard pounding of every part of the mold.

The contraction of steel being nearly, and in some shapes quite, double that of iron, care also must be exercised in preparing molds that this excessive shrinkage is not interfered with, otherwise the much dreaded shrinkage crack, or "pull," will develop, but cracks and checks must not always be laid to the molding, as in many cases it is due solely to the treatment the steel has received in process of decarborization.

After successfully making the mold, it is taken to the oven and well dried; failure to thoroughly dessicate it is a frequent cause of pit holes, rough and scabby surfaces, while when rightly made and cared for will produce a casting that cleans with comparative ease, leaving a fine blue surface. Quite a number of light intricate shapes are now cast in green sand, it being less rigid enables pieces to be made that would check in cooling if made in a dried mold. Molds skin dried with benzine flash, or otherwise, are also common practice for such lighter shapes.

After casting, when care is taken to loosen the sand to admit of contraction and the piece allowed to cool in the sand, the rule is now general to omit the annealing, which some years ago was thought essential. More particularly to heavy sections it is a question whether annealing as often practiced is not detrimental. The government still require all castings for them to be annealed, which operation the inspector may at any time witness. The Ordnance Department of the government specifies the following physical characteristics must be obtained, if possible, in

the No. 1 steel castings that are employed in the construction of gun carriages:

Ultimate tensile strength.....70,000 lbs. per sq. in.
Reduction of area at point of fracture.....36%
Elongation in two inches.....25%

A minimum toleration is:

Ultimate Tensile strength.....60,000 lbs. per sq. in.
Reduction of area at point of fracture.....30%
Elongation in two inches.....18%

The uses to which steel castings are put are beyond enumeration and are daily becoming more varied, although at the time of their introduction in this country in the seventies their position in the commercial world was one of insignificance. Limited to a few lines, the production in first years did not annually exceed two hundred tons. Steel castings now invade every field in metallurgy, save the one occupied by the chilled iron roll when used for rolling finished steel, and for that purpose no steel cast substitute has ever been considered a dangerous rival.

It is estimated that the annual production of steel castings is from eighty to one hundred thousand tons in the United States. The reports of production of steel castings as furnished to the American Iron and Steel Association, by those plants making ingots for rolling also, do not separate the tonnage of ingots and castings, hence it is to be regretted that the Association cannot give statistics of castings exclusively.

In 1872 castings of plain sections, weighing 100 pounds, sold as high as 20 to 25 cents per pound, and not many years back the price for government work was 18 cents per pound for large plain sections, but, as the demand increased, so came the capacity for supply, the latter always considerably and of late years much in excess of the former, with the natural consequence that the average price of castings is down to about three cents per pound, while favorable shapes have been sold as low as two and one-half cents per pound.

The all-absorbing topic in these war times is the make-up of our navy, and it may be worth calling the attention to the important factor steel castings play in the game of "hide and seek"

enacted in the Caribbean Sea. A warship has the following principal parts made of steel castings

Stem, stern posts, shaft hangers, stern tubes, bow and stern chocks, riding, towing and mooring bits, anchor masts, anchor crane bearings, outboard bearings, thrust blocks, large engine bed plates, engine housings, sea chest connections, pistons, etc., etc.

These parts on a first-class battleship weigh about five hundred tons, bearing in mind that this is exclusive of the gun mounts, and includes only parts of the engine and ship proper. The steel castings in a barbette carriage for a 12-inch gun weigh about 65,000 pounds.

Among the first ships of our new navy to use steel castings were the "Yorktown," "Vesuvius" and "Baltimore," built by the Cramps, and the "Atlantic" and "Dolphin," built by Roach & Son.

Earlier boats used forgings, and this is but one of many instances where expensive forgings have given way to steel castings.

In 1887 Congress passed an act providing for the manufacture of three steel cast guns, for which bids were invited; the guns were to be made of crucible, Bessemer, or open-hearth steel. One of each Bessemer and open-hearth were supplied of six-inch caliber; the weight of each of these was approximately 11,000 pounds. The former failed on the second round, and the second was subjected to statutory test of ten rounds of the highest explosive, and used in firing six-inch projectiles, two thousand feet per second speed. The only defect claimed by the government officials existing in the gun after firing was the expansion of the caliber, which measured by a Star gauge 7-1000 of an inch.

Not a few steel foundries claim that the day is coming when steel cast guns will be made equal to the expensive forged and built-up guns. What was the result after firing the first built-up gun? Had experiments ceased then, what would have been the result?

MANGANESE IN CAST IRON AND SOME EXPERIMENTS THEREON.

By GUY R. JOHNSON.

It is not the writer's intention to present a lengthy paper on the theoretical aspects presented by the alloy of manganese with cast iron, but rather a brief account of some experiments which seem to indicate that further commercial use may be made of high manganese irons.

For the sake of greater clearness, it way be well, however, to recapitulate a few of the distinctive characteristics of the metal, as follows:

Manganese is a white metal, specific gravity 8.01, as against about 7.80 for iron; an atomic weight of 54.8, as against 55.88 for iron; will combine in almost any proportion with iron; oxidizes so readily that in its present state it cannot be exposed to the air without being changed to the state of an oxide. It has a great affinity for sulphur, and to put high manganese iron in the cupola when there is trouble from sulphur, is one of the most effective methods of getting rid of the sulphur, which goes off in the form of manganese sulphide in the slag. It possesses the property when in combination with cast iron of allowing the absorption of more carbon, i. e., the theoretical maximum of total carbon being in cast iron about 4.50 per cent, and in some ferro-manganese something over 6 per cent. Moreover, manganese certainly tends to increase the carbon in the combined state, or, in other words, to make the iron harder. This fact has long been known to the makers of car wheels, rolls, etc., but even they have apparently been more or less afraid of the element, for whenever in the technical papers, on the subject, anything favorable is said, it is with the proviso that, not over one per cent should be allowed. It is rather curious that this prejudice should have sprung up, because, as Anglo-Saxons, the first irons we knew much about, were the English and Scotch brands, and there are sure to be plenty of members at this meeting who remember well the day when it was thought by many shops to

be impossible to make good, soft castings without the use of a proportion of "Scotch pig."

Now, let us glance at the analyses of some of the more famous brands:

Name.	Si.	Su.	Phos.	Man.	G. C.	C. C.	Grade
Summerlee	2.70	.010	.55	1.80			1
Summerlee	2.47	.015	.76	2.51			1
Summerlee	3.44	.015	1.00	1.70			1
Summerlee	2.70	.020	.81	2.90			2
Eglinton	2.15	.025	.62	2.80			1
Coltness	2.59	.010	.84	1.70			1
Carnbroe	1.70	.008	1.10	1.83			1
Glengarnock	3.03	.010	1.20	2.85			1
Glengarnock	4.00	.010	.9	3.41			2
Coltness	3.50	.02	.98	1.56	3.30	.20	1
Langloan	2.93	.04	.75	1.62	3.40	.46	1
West Riding of Yorkshire	1.70	.07	.36	3.60	3.42	.58	1
West Riding of Yorkshire	1.60	.07	.64	1.50	3.16	.58	2

Note.—I wish to acknowledge my indebtedness to Messrs. Wm. Kent, C. A. Meissner, and A. Vosmaer for above analyses.

Does this look as if manganese was a deleterious element? Our predecessors certainly turned out good work, and just as certainly they used in many cases a high manganese iron to do it. Furthermore, our English cousins, who run neck and neck with us in the production of castings of all sorts, are using just these brands to-day, and are doing as good, or better, work than ever with them. In short, it would seem that our foundrymen should use more manganese, rather than less, especially if they want to use much scrap, and want to remelt, for manganese protects pig iron by absorbing sulphur and oxygen, thus rendering several remeltings possible.

It was while making a high manganese iron, i. e., 2.50 to 3 per cent, that the writer was led to make the experiments which follow, and which may, it is hoped, prove the starting point for practical work along these lines.

Our ordinary method of sampling the cast iron as it runs from the furnace, is to pour a small chill every three beds, cool, break in two, and take equal portions of the drillings from each, these drillings being then thoroughly mixed, to get as nearly a perfect average analysis as possible.

With ordinary iron of the same silicon contents, 1.50 to 2

per cent, and manganese of about .80 to 1 per cent, these samples can be cooled with safety, and very rapidly, as soon as they reach dark cherry red, or blue heat. We found it was impossible, however, to treat the high manganese iron in this way, because it was made so hard that not even mushet steel would drill it.

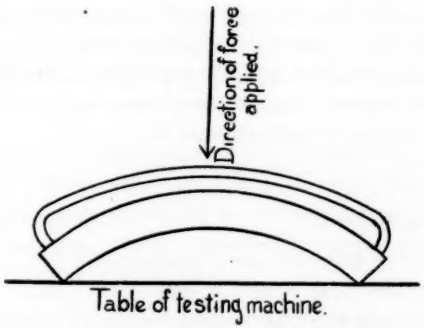
To test this the writer sent some samples to Dr. Henry M. Howe, for testing as to hardness, by his method of scratching with a diamond point. The results follow, with analyses appended:

HARDNESS OF SPECIMENS NOS. 10, 11, 12, 16, 17 AND 18, FROM GUY R. JOHNSON, FOUR MEASUREMENTS ON EACH OF SIX SCRATCHES, OR IN ALL 24 MEASUREMENTS ON EACH SPECIMEN.

	Razor.	No. 11	No. 10	No. 12	No. 16	No. 17	No. 18
Hardness, maximum	1.40	2.49	3.51	2.95	3.18	3.58	4.75
Width of scratch, minimum	1.08	1.41	1.54	2.03	2.17	2.13	2.62
Average	1.233	1.84	2.343	2.400	2.700	2.865	3.580

	Si.	Su.	Phos.	Man.	C.C.	G.C.
1321	1.44	.01	.178	3.68		
1335	1.44	.009	.207	.88		

A glance at the table shows that the high manganese iron is very much the hardest.



The next question was: What practical use can this be put to?

As there was at that time a discussion going on as to the relative value of various brake shoes, the writer determined to test the high manganese iron with a view to getting an iron that

should be at once hard, yet not so hard as to wear the wheel too much, and at the same time should be tough.

The following are the results of the experiments, and while they are incomplete, yet they afford a basis for future work along the same line by members of this association who have more opportunity and time for such work than the writer.

Experiment first—Brake shoes, Christy pattern, run direct from furnace, and cooled, respectively, one at red heat, and one at blue heat, and one unchilled. N. B. All tests were made by putting the brake shoes concave side down on the table of a 50,000 pounds testing machine, and pressing down till the point of breaking was reached, as per sketch.

Cast No. 1322, direct from furnace.

Si.	Sul.	Phos.	Man.
1.22	.011	1.85	3.61

No. 1 chilled at red heat, broke with considerable toughness, i. e., no sudden snap, at 14,600 pounds.

No. 2, blue heat, defective.

No. 3, unchilled, broke at 15,300.

Fracture in all these open and with some flaws.

Naturally, this was not satisfactory, so to establish a standard, a mixture of our strongest iron, giving tensile results of about 25,000 pounds, was used, and the experiments transferred to the foundry. The special iron, or "machinery iron," as we term it, brake shoe, with an average analysis of:

Si.	Sul.	Phos.	Man.
1.25%	.020	.189	.75

gave results as follows:

Chilled at red heat, defective, cracked.

Chilled at blue heat, sound, 26,650.

Unchilled, sound, 21,500.

The chilled shoes, however, broke with a sharp snap, showing no toughness, but great transverse strength.

Test No. 3. Cast No. 1316:

Si.	Sul.	Phos.	Man.
1.96	.024	.189	2.92

Melted in foundry—
Cast against chill plate, 21,000 lbs.
Chilled at red heat, 19,500 lbs.
Chilled at blue heat, 23,600 lbs.
Unchilled, 22,600 lbs.

Several other tests of the same cast showed that the high manganese iron chilled at blue heat gave uniformly the same results. The pieces chilled against an iron plate were kindly tried for the writer by the Southern Railroad, but while showing toughness, were too soft.

The shoes chilled at red heat were too brittle, and so hard that they could not be touched with a drill, which, of course, indicates they were too hard for practical use, but those chilled at blue heat showed greater toughness than the ones made of our strongest iron; although not so strong, they drilled with great difficulty, and the resultant drillings were very fine—nothing more than powder, in fact. Unchilled, the shoes were much too soft.

In short, the sum of the results seemed to be that very great hardness, with good strength and toughness, might be obtained by using high manganese iron and chilling at blue heat.

Dr. Howe's experiments show how much harder than ordinary iron this alloy is, and it is sincerely hoped by the writer that practical use can be made of the idea.

The Chairman: The paper of Mr. Johnson is before you for discussion. I think Mr. Seaman and his next door neighbor are men who can speak practically as to the effect of manganese on chilled iron castings. Both represent the largest concerns in the country for making chilled rolls.

Mr. Seaman: I do not know that I can give you any information in the matter. It is very much in a line entirely different from what I am working in. I would say, however, that we are making some experiments, and it may take us six months to get through with them. When results are accomplished we will take pleasure in giving you the results.

XUM

Mr. West: I should like to ask Mr. Johnson whether he can tell by the fracture of his pig, in an approximate way, what manganese it might contain?

Mr. Johnson: No, I cannot say that there is, as a matter of fact, any way of ascertaining high manganese by eyesight. A pig shows, or is apt to show, a white ring, almost invisible to the naked eye, around it. But I do not think, from seeing pig iron running .05 per cent to 3½ per cent, that there is any special difference. It is absolutely impossible to tell. The way I should judge, if I had suspicion, would be more by fracture. The manganese has a great tendency to open an iron up, and when making No. 1 pig, which has less than 1 per cent, and No. 2, it is very marked. It is also very soft iron, and very graphitic.

Dr. Moldenke: I was greatly interested in those analyses. Is it possible for you to get good results with irons so high in manganese, unless conditions are as in Europe, where there is so much sulphur in the coke used in the cupola?

Mr. Johnson: In castings we lose less than ½ per cent of manganese.

Dr. Moldenke: The point of interest for foundrymen is, what is the resulting casting coming from those irons?

Mr. Johnson: The result in 3 per cent would be about 2½ per cent manganese. It analyzes about .06 in sulphur, and that is almost entirely removed.

The Chairman: The next paper will be read by title only, "Incombustible vs. Combustible Foundry Buildings.".

INCOMBUSTIBLE VERSUS COMBUSTIBLE FOUNDRY BUILDINGS.

By O. BENSON, C. E.

Strength, Durability, Cost and Economy in Fire Risks.

Two years ago I wrote an article on "Iron Foundry Buildings," which appeared in The Foundry April, 1896. I thought this article covered about all I knew that would be of interest to foundrymen, but your able and enterprising secretary has asked me to write something more for the June meeting of the "American Foundrymen's Association," and after some hesitation I promised to contribute a short paper.

I infer from Mr. Penton's letter that he desires that I discuss the relative merits of wood and steel construction; "strength, durability, freedom from fire, economy from insurance," etc., with some emphasis on the financial aspect of the case. Which is a rather broad subject for a short paper.

The Bessemer process has so reduced the cost of steel production that soft steel is used almost exclusively for structural work. Its strength being superior to that of iron, the latter is seldom used, except for rods, nuts and other small parts, and hence steel is the metal with which we have to deal chiefly in structural work.

In discussing the relative merits of wood and steel construction, it is fair at the outset to consider the different conditions with which they have to contend. The average wooden foundry building is designed by some carpenter, who nails pieces of wood together until he finds that the resulting structure will stand alone and keep out the rain, when he demands and receives his pay. Such structures are usually built with an utter disregard for fire risks, in fact, it sometimes almost seems to me that the builder must be in league with the fire fiend. In a year or two the roof may begin to sag and leak; while the continued heat causes timbers to shrink and joints to pull out.

If such a building contains cranes and shafting, these are con-

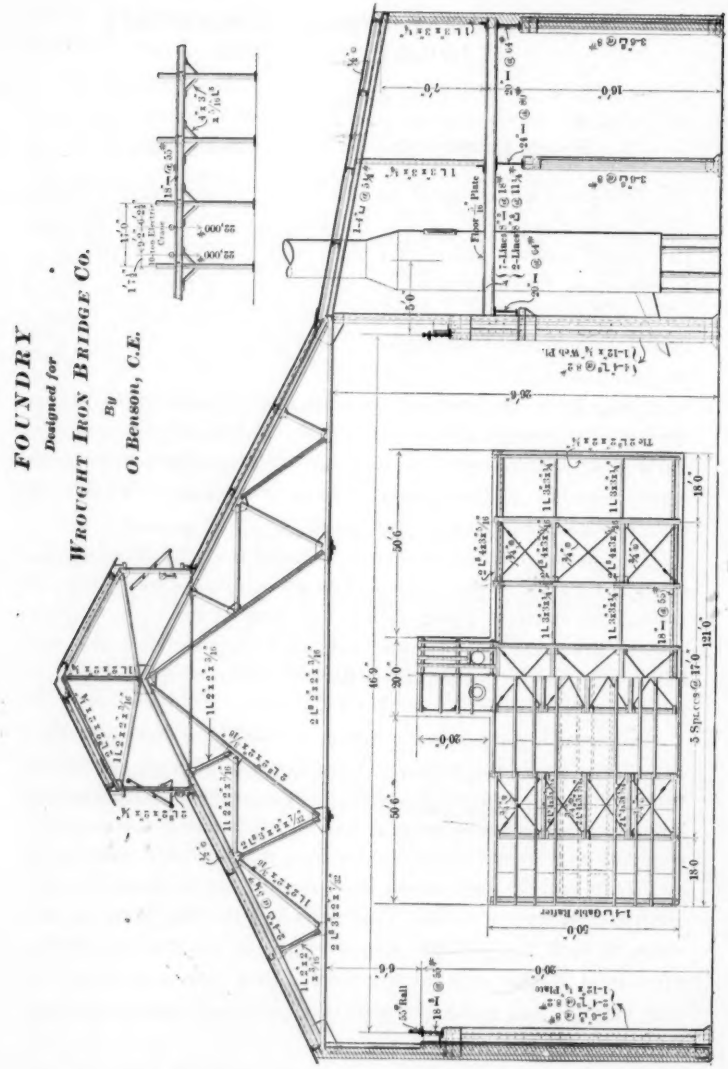


FIG. 1.

tinually thrown out of plumb and out of line, causing much trouble and loss of power from friction.

And now let us see under what conditions a steel structure must be built. Custom and long experience have caused certain conditions and specifications to be accepted as "standard," the chemical and physical characteristics of material to be used must be determined by actually testing sample pieces; and then the tension strain per square inch and the compression strain per square inch, which must not be exceeded under various conditions, are pretty clearly defined by experience and established custom.

The first-class concerns, whose business it is to handle such work, each build several hundred structures of various kinds every year, and hence know just how to attack almost any problem in metal construction in the most approved and thoroughly scientific manner. When concerns of this kind are about to construct a modern foundry building, for instance, their engineers first ascertain what conditions are to be considered; the kind of hoisting apparatus to be used, the number, capacity and location of cranes and other machinery, etc., etc.; and from these conditions, together with snow, wind, and other loads, the strains on every piece of steel in the structure are accurately calculated and its form and size determined. So systematically has this work come to be arranged that the number and position of every rivet is exactly determined by means of rules and standards established by the engineers, and drawings show just what is to be done, so that nothing is left for inexperienced men to guess at. This is in sharp contrast with the methods used in wooden construction. If a steel structure sags or fails, a "kick" is made right off; the firm that built it will hear the unpleasant news pretty quick, and its engineer have cause to grieve; for competitors will see that prospective customers, for some years to come, hear the story of said failure with such embellishment as fertile imaginations may suggest.

With a wooden structure, the superintendent simply sends up a few men to repair the roof and spike on some timbers from time to time, while loss of power and inefficiency of cranes and ma-

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chinery steal upon him so insidiously that he gives little thought as to their cause or sets them down to natural "wear and tear;" and, in case of total collapse, "unusual action of the elements" is given as the cause; but such a disaster would naturally occur during a storm. So you see that the builder of steel structures who has a reputation at stake must contend with more severe requirements than those imposed upon his wood competitor, and

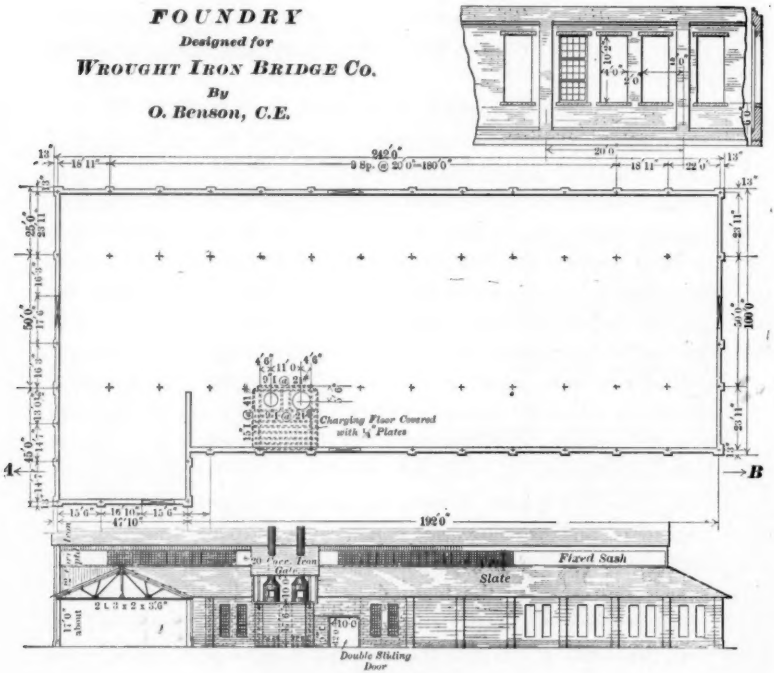

FIG. 2. ***Section A-B***

this fact, I think, should be given considerable weight in discussing the relative merits of steel and wood construction.

So far as strength goes, a wooden structure can be made sufficiently strong to answer ordinary requirements when new, provided the joints are properly made and loads from cranes or similar machinery are not very great. In the matter of "strength"

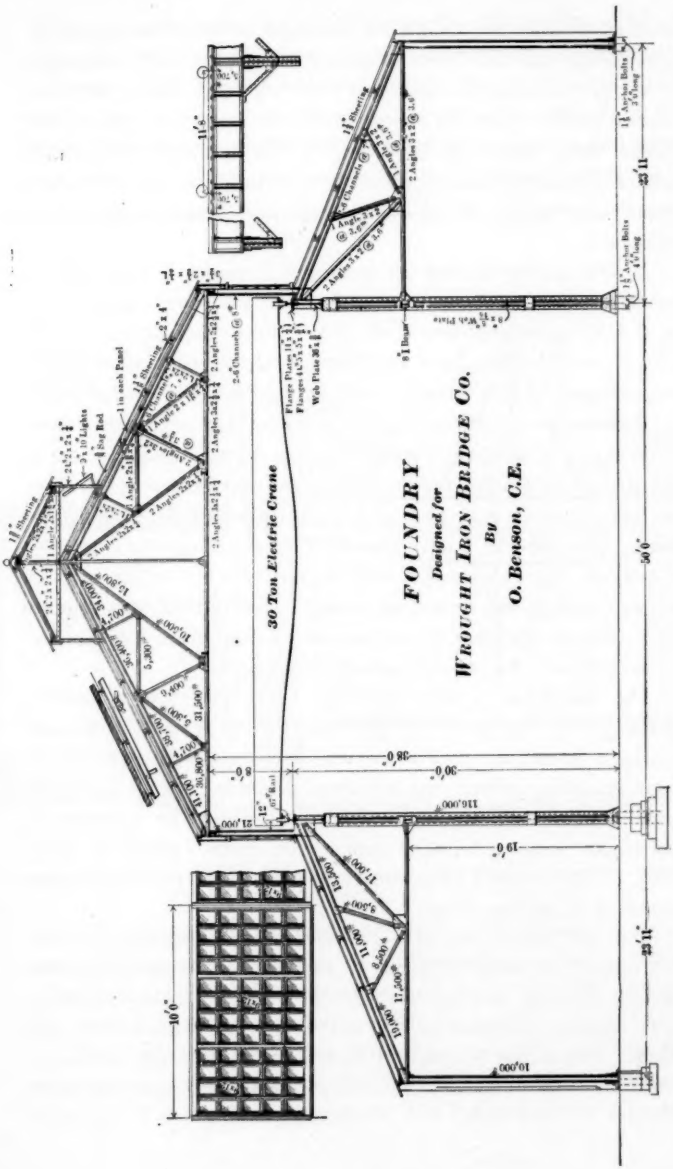
FOUNDRY
Designed for
WROUGHT IRON BRIDGE Co.
By
O. Benson, C.E.
30 Ton Electric Crane
50'0"
38'0"
30'0"
8'0"
19'0"
10'0"
23'11"
11'6"
110,000
51,000
10,000

FIG. 3.

steel structures can always be designed to meet any given requirements, and their field of usefulness is practically unlimited.

As to durability, we all know that wooden foundry buildings require rather extensive repairs every few years, provided they escape being taken off by fire in the prime of youth. While neither of these remarks applies to a steel building, and with occasional painting the life of such a structure should be practically unlimited.

In the matter of cost, let us briefly consider a roof truss of sixty feet span by itself. Assuming that the same engineer designs both a wooden and steel truss—the former provided with proper joint blocks, straps and bolts—and the latter scientifically proportioned in all its details—we will find that the cost of building them is about the same; and if we pursue our investigation further we will find that a steel truss has the advantage in cost as the span or the load increases, while a wooden truss is apt to show the lesser cost as span or load are diminished. To make my remarks more specific, I have selected four drawings from our files of designs. Fig. (1) shows a small foundry 121 feet by 50 feet, with cupola house 20 feet square adjoining, covering in all 6,450 square feet. This is designed for the use of a 10-ton electric crane, and is covered with No. 20 corrugated iron, painted.

Fig. (2) shows a plan, and Fig. (3) a section of a foundry building, covering 25,200 square feet, which is designed to accommodate a 30-ton traveling crane, and is covered with slate laid on wood sheeting, except cupola house, which is covered with corrugated iron; and Fig. (4) (reproduced from The Foundry of April, '96) shows a foundry with 25-ton crane, carried by brick walls. This covers 13,800 square feet, and is covered with slate laid on steel purlins direct.

You will notice that in Figs. (1), (2) and (3) the roof is carried entirely on steel columns, so that the wall simply takes the place of sheeting, and can be made quite thin. The saving effected in reduced thickness of wall will nearly cover the cost of columns. The writer has used 8-inch and 10-inch hollow tile for filling between columns in this manner with very satisfactory results.

There are many kinds of roof coverings on the market, of which corrugated iron is probably pushed forward more persistently than any other. In the writer's opinion, this is not well suited for the roof of a first-class foundry. It is very difficult, in the first place, to make it sufficiently tight to keep out rain and snow (especially the latter), and as you all know, it is possible for a

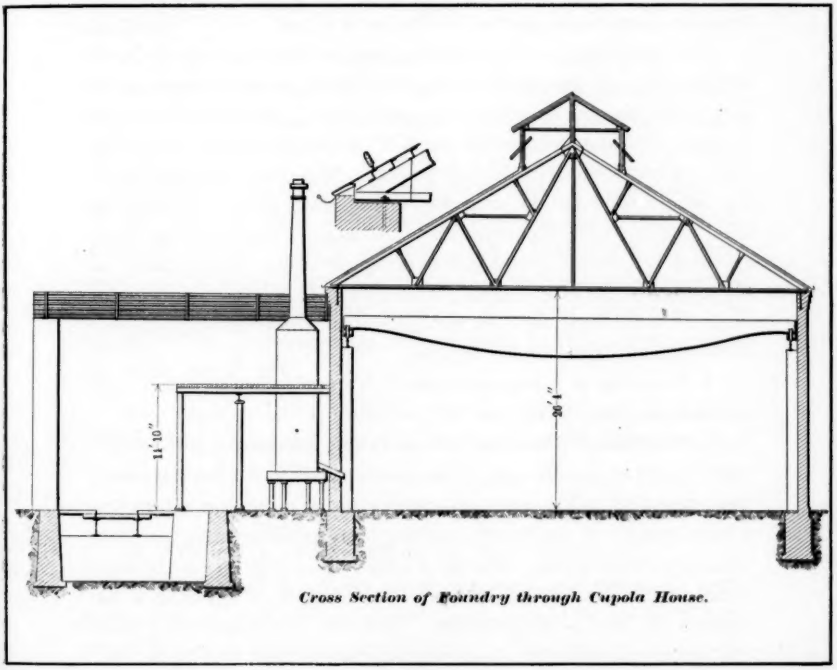

FIG. 4.

drop of water, applied at the wrong place, to bring about a rather unsatisfactory state of affairs in its immediate vicinity. Gases around a foundry attack corrugated iron pretty severely, and unless carefully painted at frequent intervals, its life is rather short.

There are a large number of roofing "compositions" on the market, some of which the writer believes are better and cheaper than any of the ordinary materials; but I find that the selection

of one is much like taking a chance in some lottery: we may draw a prize, but are apt to find, a year or two after investing, that we have a leaky roof on our hands. The most reliable roof covering is a good quality of slate secured to steel purlins, as shown in Fig. (4), or laid on wood sheeting. Standing-seam galvanized iron or tin also makes a good cover. When slate is laid on steel purlins direct, a thin layer of cement should be used between them to insure the exclusion of snow.

The foundry building represented by Fig. (1) would cost $6,000 here in Ohio erected complete above the foundations, covered with No. 20 painted corrugated iron. A well-constructed wooden building, with brick walls of proper thickness, wood columns, girders, etc., would cost $4,800. Slate laid on wood sheeting would increase the cost $200; and slate secured directly to steel purlins would increase the cost $550. The building Figs. (2) and (3) would cost $15,600 complete above foundations, as shown, covered with sheeting and slate. If No. 20 painted corrugated iron were used on roof the cost would be $14,950, and with slate on steel purlins $16,750.

A first-class wooden structure with suitable brick walls would cost $2,500 less.

I do not think it necessary to carry any insurance on the structures illustrated, although I once knew a smooth-tongued insurance agent to talk a man into taking out a policy on a building which contained absolutely nothing combustible, either in construction or contents. The roof sheeting of Fig. (3) is the only combustible material shown, and the danger of igniting a flat surface like this is insignificant. The rate of insurance on foundry buildings of modern construction ranges from 1 to 3 per cent., depending upon general arrangement, location and fire protection.

Assuming that 2 per cent is a fair premium on building and contents, with a building valued at $10,000 and contents, including machinery and equipment, valued at $10,000, total $20,000, our annual premium would be $400.

This would pay the interest at 7 per cent. on $5,700. We would, therefore, be justified in adding that sum to the cost of

our building, in view of saving to be effected on account of insurance alone. We would also escape the danger of losing time and trade which always accompanies a "fire," and which insurance policies never cover.

With a foundry building, the contents, although not in themselves combustible, would be ruined by burning the building; hence, by making the building incombustible, we save insurance on both.

In conclusion, I think we are justified in adding from 30 to 60 per cent to the cost of our foundry building for the purpose of insuring us against fire, with its attendant losses and annoyance.

If there is any discussion on this we shall be glad to have it. If not, we will have as unfinished business the report of the committee on the form of test bars. Dr. Moldenke is the chairman of that committee. Then there is the committee report on Standardized Drillings for Analysis, Mr. West chairman. The report of the Committee on Amendments to the Constitution is in order, Mr. Yagle.

Mr. Yagle: The Committee on Amendments to the Constitution have placed the papers in the hands of the Secretary, and he will please read them.

The Secretary read amendment as follows:

To Article III. add the following, to be Section 4:

"Any member in arrears for six months, and failing to remit same after receiving three notifications, should be dropped from membership, and his name published in the Journal of the Society."

This amendment caused considerable discussion, taken part in by the Chairman, Dr. Moldenke, Thos. D. West, C. S. Bell, Mr. Gates and the Secretary; Mr. Gates offering the following resolution as a substitute to the amendment:

Mr. Gates: Perhaps you can read this resolution in better shape. "Resolved, That the Secretary is hereby instructed to notify each member when his annual dues are payable, and in

case said dues remain unpaid for 30 days, he shall mail him a second notice that he will make draft in 10 days from that date for the amount, and if not paid their names will be dropped from the rolls forthwith."

After some further discussion, the amendment was amended to read: "Resolved, That the Secretary is hereby instructed to notify each member when his annual dues are payable, and in case said dues remain unpaid for 30 days, he shall mail him a second notice that he will make a draft in 10 days from that date for the amount."

The Chairman: I will call on Mr. Seaman for a few pertinent remarks in regard to the Association, its welfare and progress.

Mr. Seaman: I do not know that I can suggest anything of value in the matter, but I should like to call your attention to a subject which we shall have to consider. That is in regard to the place for holding the next meeting. I believe it is understood that the next meeting should be held in Pittsburg. We shall be very glad to have you come there and we shall be able to show you considerable that will be of interest to you. I cannot say now what we will show you, but I will say this, that two weeks ago our Chamber of Commerce closed up their year's business, and our tonnage of shipping last year was something over four thousand four hundred and seven millions of tons shipped by water and rail. That will give you a little idea of Pittsburg. As to the town, a great many of you know something of it. I will, however, mention a few things you are not probably so well posted on and which we have. We shall have pleasure in showing you when you come there the works at which the shells were made by which "Dewey did it." Shells from the same place are now being used in Cuba, and a good deal of our armor plate is on the vessels, so you will hear of Pittsburg. Now, this is all I proposed to mention. We have a valley there which we will take you through, and on one side of the mountain we have a river, and on the other is a line of the largest works and finest foundries in the city. We will take you all on Mount Washington in the evening and show you a panoramic view, with probably 35 con-

verters going, and you will possibly see a sight you have never seen before. I would like, also, to say this. I think we have in Pittsburg the finest women in the world, and we propose to maintain our position in that respect—unless you bring along your women and prove it to the contrary. If you do, I will promise you our women will take care of them, but we will not trust you men with our women.

Mr. Best: It occurred to me, hearing the suggestion of Mr. Penton, in which he mentioned our Journal, that it should be classed as one of the best in the trade on this continent. It gives the greatest amount of information for the least amount of money paid for it, and if anyone refuses to pay the small amount asked for dues, it is beyond my thought. In the event of our objection to publish the names, I think it would be advisable that we should get at least once a year a list of members in good standing. In that way we may see what our membership is. Those who are members in name, and name only, will probably get hold of one of these sheets and ask why their names are not there. That would probably be to them anticipation, and would lead them to pay up their dues.

The Chairman: Mr. Seaman's remarks are to the point. We have already a plan in thought which contemplates the publication of the list of members in one of the numbers of our Journal. We are now ready for the report of the Committee on Nominations.

Mr. J. S. Stirling: In presenting our report on Nominations, I wish to say that one member of our committee seemed to find it embarrassing in the preparation of the repoprt, but in everything we were unanimous, with the exception of the nomination for the Northwestern States, but the member realized that the majority ruled and acquiesced. The following is the report:

To the American Foundrymen's Association:

Your Committee on Nominations beg to present the following:

For President—Mr. C. S. Bell, Hillsboro, O.
For Secretary—Mr. Jno. A. Penton, Detroit, Mich.
For Treasurer—Mr. Howard Evans, Philadelphia, Pa.

XUM

For Vice-Presidents—
New England States—Mr. C. L. Newcomb, Holyoke, Mass.
Middle States—Mr. I. W. Frank, Pittsburg, Pa.
Southern States—Mr. E. H. Putnam, Atlanta, Ga.
Central States—Mr. Chas. A. Bauer, Springfield, O.
Northwestern States—Mr. C. J. Wolff, Chicago, Ill.
Southwestern States—Mr. W. S. Mosher, Dallas, Texas.
Pacific States—Mr. R. Chartrey, San Francisco, Cal.
Canada—Mr. Jos. Best, Montreal, P. Q.

Respectfully submitted,
JAMES S. STIRLING,
Chairman.

Mr. West: I move that the nomination be closed.

Motion put and carried.

Dr. Moldenke: I move that the Secretary be instructed to cast a ballot electing the gentlemen named in the report.

Motion duly put and carried, and the ballot cast by the Secretary, who then declared his act.

Mr. Bell: I was never more surprised at anything in my life than that I should be elected to preside over this Association. While I appreciate the honor from the bottom of my heart, I cannot help thinking that you have made a mistake. While I am heart and soul interested in the organization, still I think there are persons better fitted to conduct the affairs, and I feel my inability to meet the requirements of the office—but you have willed it so. While I am on the floor, I wish to say that this Association, every member of other Foundrymen's Associations, and every foundryman in this country are indebted to our late President for the successes of this Association and the advancements of the interests of the foundrymen of America.

Mr. Schumann: I take the liberty, Mr. Bell, of escorting you to the chair. In thanking you, gentlemen, for the good wishes and support given me during the past two years, and for your hearty co-operation, I can only say that I have missed at least

25 years of pleasure in not knowing you earlier. As foundrymen, we have been going through life in a dry sort of way and never knew there were such agreeable and pleasant men engaged in the business. We have, however, discovred it now, and while late it is better than never. I am highly gratified at the success you have had in urging Mr. Bell to assume the Presidency. For a man of integrity, reputation and behavior, I do not believe anyone in the whole world is his superior. You may perhaps find some nearly his equal, but none his superior. I know that under his guidance we shall continue in our past course in the elevation of the foundry business to where it belongs. It is getting more important from day to day and year to year. We are beginning to realize that after all we represent a very important industry in this country, and that we are going on in the right way. The best evidence of progress is the fact of having Mr. Bell in the chair. I know you will accord to Mr. Bell the support you gave me.

Mr. Bell: My only regret about the matter is that I am not best able to maintain the Association in the high standard it has reached under Mr. Schumann's supervision. It will require the co-operation of every member to maintain and increase the force and advantages of the Association; and while it may be that I hold this position without the jealousy of a single soul, I shall expect of you that same hearty and liberal co-operation you have so liberally and honorably extended to the late President. Now, I want to say one word here for our Pittsburg friends, and that is, that when I first entered the foundry business it was in Pittsburg, and I can assure you that it will be a great pleasure to go back there at the head of this Association of the foundrymen of the United States. What other business is there? Mr. Penton, you have been elected Secretary of the Association, and we shall be pleased to hear from you.

Mr. Penton: I said last year in Detroit that I did not promise anything, and I do the same this time. I will try to be a better boy and not stay out at night. It is a labor of love with me, as it is with the rest of you, and I have not succeeded in doing as much as I should like.

Mr. Schumann: I would say that Mr. Evans has been unfortunately under the weather, and so could not attend the convention. We cannot, therefore, hear from him upon his re-election.

Mr. Bell: It would be agreeable, if possible, to have the Executive Committee meet before our separation to-day. I do not know how many are present, but probably there are enough in a measure to outline the purposes of the future, and I should be glad to meet with them. I know the members of this Association are heartily in accord as to the efficiency of the services rendered to the Association by our last President, but I should feel guilty if I did not say a word on the subject. I know every member who has watched the growth and development of this organization in every trying place, has found Mr. Schumann a host in himself, and I say he deserves the hearty thanks of this organization, and I move you, gentlemen, that we tender those thanks to Mr. Schumann, aside from the fact that we shall ever cherish our gratitude to him, and that we tender our thanks by a rising vote.

Mr. Seaman: I second that motion, and would say that I should like to see him elected an honorary member of this Association.

Mr. West: That is a motion, and I second it.

Both motions were duly put and carried by a rising vote, which was unanimous.

Mr. Bell: Mr. Schumann, you will please now recognize yourself as a life member of this Association.

Mr. Schumann: I am sorry I am not a skilled speaker. If my friend Mr. Lanigan were here I would request him to speak for me. Knowing my defects in this respect, I will simply say that the few words I have used in no way express all I feel. It is by no means a slight honor that I have received at your hands, and you know I appreciate your regard most highly.

Mr. Bell: What are the further wishes of the meeting?

Mr. West: I would like to say a word in reference to the committee of which this Association has honored me with the

chairmanship. In regard to the question of establishing a central standardizing agency for the distribution of drillings, the work is one of large import, and I trust all the members of this Association will assist in any way they can to give the committee an opportunity to secure orders and advance the work. I take this occasion to call attention to the importance of this work.

Mr. Guy Johnson: Before we adjourn I move a vote of thanks be tendered to the foundrymen and others of Cincinnati for the courtesies extended to us while here.

Motion duly seconded, put and carried.

The convention then on motion adjourned sine die.

XUM

A LIST OF THOSE WHO ATTENDED THE CINCINNATI CONVENTION.

Francis Schumann, Tacony Iron & Metal Co..Philadelphia, Pa.
Jos. T. Best, Warden, King & Son.....Montreal, P. Q.
I. W. Frank, Frank-Kneeland Mach. Co.....Pittsburg.
W. E. Sessions, Sessions Fdry. Co.....Bristol, Conn.
E. H. Putnam, Southern Agricultural Works.....Atlanta, Ga.
C. S. Bell, C. S. Bell Co.....Hillsboro, O.
Alva Carpenter, A. Carpenter & Son.....Providence, R. I.
P. W. Gates, Gates Iron Works.....Chicago, Ill.
Jas. R. Bowron, Tenn. Iron, Coal & R.R. Co.Chattanooga, Tenn.
A. I. Findley, Iron Trade Review.....Cleveland, O.
John A. Penton, "The Foundry".....Detroit
T. L. Griffith, Hill & Griffith Co.....Cincinnati, O.
John Hill, Hill & Griffith Co.....Cincinnati, O.
J. D. Smith, J. D. Smith Fdy. Supply Co.....Cincinnati, O.
J. W. Fleig, J. D. Smith Fdry. Supply Co.....Cincinnati, O.
W. H. Pfahler, Abram, Cox Stove Co.....Philadelphia, Pa.
C. T. Holbrook, Davis Coal & Coke Co.....Philadelphia, Pa.
F. S. Cadwell, Hill & Griffith Co.....Cincinnati, O.
H. F. Frohman, S. Obermayer Co.....Cincinnati, O.
G. B. Buckingham, Arcade Mall. Iron Co....Worcester. Mass.
L. S. Brown, Springfield Facing Co.....Springfield, Mass.
J. S. Koons, Lehigh Valley R. R.....Weatherly, Pa.
T. H. Colvin, Colvin Fdry. Co.....Providence, R. I.
Geo. H. Lincoln, G. H. Lincoln Iron Works.....Boston, Mass.
J. F. Lanigan, Davis Fdry. Co.....Lawrence, Mass.
Victor Swenson, Condor Iron Fdry. Co.....Boston, Mass.
Stephen Holman, Deane Steam Pump Co.....Holyoke, Mass.
C. L. Newcomb, Deane Steam Pump Co.....Holyoke, Mass.
Edward Maher, Maher & Lockhart.....Newark, N. J.
B. Gomersall, Leland & Faulconer Mfg. Co.....Detroit, Mich.
R. Viall, Brown & Sharpe Mfg. Co.....Providence, R. I.
John R. Russel, Russel Wheel & Fdry. Co.....Detroit, Mich.
J. S. Seaman, Seaman, Sleeth Co.....Pittsburg, Pa.

Dr. R. G. G. Moldenke, McConway, Torley Co.....Pittsburg.
Henry Hansen, "The Foundry".....Detroit, Mich.
M. F. Moore, S. L. Moore & Sons Co.....Elizabeth, N. J.
John Kayne, Keermayer Mfg. Co.....Fort Wayne, Ind.
J. A. Logan .....Pittsburg
John F. Mills, Abendroth Bros.....Port Chester, N. Y.
J. J. Burgen, Lane Mfg. Co.....Montpelier, Vt.
S. D. Sleeth, Westinghouse Air Brake Co.....Pittsburg.
C. A. Sercomb.....Milwaukee, Wis.
A. J. Wentworth, Rogers, Brown & Co.....Cincinnati, O.
B. D. Northrup .....Washington, Pa.
H. M. Leland, Leland & Faulconer Mfg. Co.....Detroit
H. M. Wilson, Taylor-Wilson Co.....Pittsburg
J. S. McCormick, J. S. McCormick Co.....Pittsburg
Philip Mathes, Brittain & Mathes.....Pittsburg.
J. W. Treat, C. A. Treat Mfg. Co.....Hannibal, Mo.
L. D. Gilbert, Frick Co.....Waynesboro, Pa.
B. T. Bacon, Pickands, Brown & Co.....Chicago.
Wm. Yagle, Wm. Yagle & Co.....Pittsburg.
D. G. Moore, Samuel L. Moore & Sons Co....Elizabeth, N. J.
W. A. Jones, W. A. Jones Fdry. & Mach. Co.....Chicago.
B. M. Gardner, "Iron Trade Review".....Chicago.
Chris. J. Wolff, L. Wolff Mfg. Co.....Chicago
Charles Herron, Ross, Mehan Fdry.....Chattanooga, Tenn.
S. T. Johnston, S. Obermayer Co.....Chicago.
G. W. Cope, "The Iron Age".....Chicago.
L. E. Bellows, Deane Steam Pump Co.....Holyoke, Mass.
E. J. Lyon, Brown & Sharpe Mfg. Co.....Providence, R. I.
E. S. Reid, Whiting Fdry. Equipment Co.....Chicago
J. K. Pollock, Rogers, Brown & Co.....Cincinnati, O.
C. J. Langdon, Fulton Foundry Co.....Cleveland, O.
W. T. White, J. D. Smith Fdry. Supply Co.....Cincinnati, O.
J. A. Stone, Riverside Fdry. Co..... Cleveland, O.
J. P. Golden, Golden's Fdry. & Mach. Co.....Columbus, Ga.
O. T. Davis, Frick Co.....Waynesboro, Pa.
John G. Sadlier, Springfield Fdry. Co.....Springfield, O.
M. L. Milligan, Springfield Foundry Co.....Springfield, O.

XUM

Geo. McG. Morris, J. B. Morris Fdry. Co.....Cincinnati, O.
E. W. Husted, Snow Steam Pump Works.....Buffalo, N. Y.
E. Robinson, Wells Light Mfg. Co.....New York
H. E. Morrill, Dayton Mall. Iron Co.....Dayton, O.
Robt. C. Folney, Lobdell Car Wheel Co.....Wilmington, Del.
E. H. Mumford, Tabor Mfg. Co.....Elizabeth, N. J.
Archer Brown, Rogers, Brown & Co.....New York
D. B. Meacham, Rogers, Brown & Co.....Cincinnati, O.
W. C. Herron, Rogers, Brown & Co.....Cincinnati, O.
F. D. Carney, Ludwig, Loewe & Co.....Berlin, Germany.
John B. Morris, John B. Morris Fdry. Co.....Cincinnati, O.
D. B. Hyde, Safety Emery Wheel Co.....Springfield, O.
J. D. Rogers, Safety Emery Wheel Co.....Springfield, O.
J. M. Warner, Rogers, Brown & Warner.....Philadelphia, Pa.
Charles Hoefinghoff, Hoefinghoff & Laue Fdry. Co..Cincinnati.
E. M. Drummond, Drummond Mfg. Co.....Louisville, Ky.
Chas. Klein, Lane & Bodley Co.....Cincinnati, O.
N. P. Hyndman, Washington Coal & Coke Co.....Pittsburg
S. S. Gaylord, Cleveland Facing Mill Co.....Cleveland, O.
Geo. R. Lombard, Lombard Iron Works.....Augusta, Ga.
F. A. Goodrich, F. A. Goodrich & Co.....Detroit, Mich.
W. Stein, Whiting Fdry. & Equipment Co.....Harvey, Ill..
Thos. D. West, Thos. D. West Fdry. Co.....Sharpsville, Pa.
G. S. Lombard, Lombard Iron Works.....Augusta, Ga.
W. C. Swift, Henry E. Pridmore.....Chicago, Ill.
F. M. Bookwalter, James Leffel & Co.....Springfield, Ill.
Henry Bond, American Radiator Co.....Buffalo, N. Y.
C. E. Bell, C. S. Bell Co.....Hillsboro, O.
S. S. Knight, Warder, Bushnell & Glessner Co..Springfield, O.
R. C. Augur, New York Air Brake Co.....Watertown, N. Y.
J. R. Homer, Galion Fdry. & Mach. Co.....Galion, O.
W. W. Cheney, S. Cheney & Son.....Manlius, N. Y.
Wm. H. Switzer, Superior Fdry. Co.....Little Falls, N. Y.
Jas. H. Tuttle, S. Cheney & Son.....Manlius, N. Y.
H. M. Lane, The Lane & Bodley Co.....Cincinnati, O.
G. W. De Smet, Garden City Sand Co.....Chicago, Ill.
Jas. S. Stirling, Harlan & Hollingsworth Co..Wilmington, Del.

Fred. J. Brunner, J. D. Smith Fdry. Supply Co...Cincinnati, O.
M. C. Gauley, Connersville Blower Co.....Connersville, Ind.
W. D. Patton, Rogers, Brown & Co.....Cincinnati, O.
A. P. Ford, Crane Co.....Chicago, Ill.
C. H. Schwab, Genesee Fdry. Co.....Genesee, N. Y.
F. E. Nulson, Missouri Mall. Iron Co.....E. St. Louis, Mo.
J. T. Wilkin, Connersville Blower Co.....Connersville, Ind.
E. M. Cross, Keystone Coal & Coke Co.....Pittsburg, Pa.
J. C. Reed, Keystone Coal & Coke Co.....Pittsburg, Pa.
W. M. Singer, Keystone Coal & Coke Co.....Pittsburg, Pa.
E. Pitcairn, Keystone Coal & Coke Co.....Pittsburg, Pa.
E. Edwards, General Electric Co.....Lynn, Mass.
Thos. H. Simpson, Michigan Mall. Iron Co.....Detroit, Mich.
J. D. Brennan, Michigan Mall. Iron Co.....Detroit, Mich.
F. E. Gordon, Ohio Sand Co.....Conneaut, O.
Geo. Mesta, Leechburg Fdry. & Mach. Co.....Pittsburg, Pa.
Rudolph Wegelin, Howard Harrison Iron Co...Bessemer, Ala.
J. Stewart, Bradford Milling Co.....Cincinnati, O.
W. A. Hall, Niles Tool Works .....Hamilton, O.
F. V. Knauss, Portsmouth Stove & Range Co..Portsmouth, O.
Wm. Fischer, Globe Iron Works.....Dayton, O.
Dave Smith, W. P. Callahan & Co.....Dayton, O.
A. F. Koons, Webster, Camp & Lane.. .....Akron, O.
W. A. Haven, Jas. L. Haven Mall. Iron. Co.....Cincinnati, O.
C. J. Stewart, Marmet, Smith Coal & Coke Co....Cincinnati, O.
R. A. Suit, Marmet, Smith Coal & Coke Co.....Cincinnati, O.
Louis G. Keck, Bickford Drill & Tool Co.....Cincinnati, O.
H. G. Byram, Cleveland Fencing Co.....Indianapolis, Ind.
Wm. C. Doherty, Doherty Bros.....Lowell, Mass.
William Cureton, C. D. Cooper & Co.....Mt. Vernon, O.
T. H. Gartland, Gartland Fdy. Co.....Cleveland, O.
W. P. Smith, Chris. Erhart .....Cincinnati, O.
E. F. Cook, Iron Castings Co.....Cincinnati, O.
R. Bahman, Blymer Iron Works Co.....Cincinnati, O.
M. J. Pero .....Fitchburg, Mass.
John A. Oberhelman, C. F. Thauwald & Co.....Cincinnati, O.
W. H. Orcutt, McIlwaine & Richards Co.....Noblesville, Ind.

Andrew Macduff, Stillwell-Bierce-Smith-Vaile, Co., Dayton, O.
P. E. Montanaus, Springfield Mach. Tool Co....Springfield, O.
Frank B. Ward, Michigan Brass & Iron Co.....Detroit, Mich.
H. M. Norris, Bickford Drill Co.....Cincinnati, O.
Geo. W. Getz .....Chicago, Ill.
C. M. Miller, Gartland, Fdry. Co.....Cleveland, O.
Chas. E. Hoyt, Lewis Institute.....Chicago, Ill.
A. G. Wilson, Hoefinghoff & Laue .....Cincinnati, O.
Theo. Ballman, Hoefinghoff & Laue.....Cincinnati, O.
Daniel McLaren .....Addyston Pipe & Steel Works.
S. E. Hilles, Samuel C. Tatum Co.....Cincinnati, O.
Monte L. Greene, "The Spokesman".....Cincinnati, O.
A. L. Carleton.....Hartford, Conn.
J. C. Alley, C. L. Pierson & Co.....Boston, Mass.
G. P. Smallman .....Chicago, Ill.
Chas. L. Miner, Matthew Addy & Co.....Cincinnati, O.
Wm. R. Warner, Matthew Addy & Co.....Cincinnati, O.
John E. Donovan, The Standard Iron Split Pulley Co. Cincinnati
Charles B. Erhart, Chris. Erhart Fdry. & Mach. Works,
Cincinnati, O.
A. S. Oberding, Eureka Fdry. Co.....Cincinnati, O.
Geo. F. Crivel, F. B. Stevens.....Detroit, Mich.
S. P. Bacon.....Cincinnati. O.
G. S. Campbell, Campbell Ptg. Press. Co.....Plainfield, N. J.
J. Eckhardt, Eckhardt & Raible.....Cincinnati, O.
F. W. Bauer, Chemist.....Springfield, O.
J. D. Burgess.....Cincinnati, O.
Chas. L. Bauer, The Warden, Bushnell & Glessner Co.,
Springfield, O.
J. D. Leary, Queen City Fdry.....Cincinnati, O.
Wm. Manley, Queen City Fdry.....Cincinnati, O.
J. W. Foley. Jr., J. W. Foley & Co.....Cincinnati, O.
Colonel Cornelius Cudle.....Cincinnati, O.
Geo. M. Clark, Mitchell, Tranter Co.....Cincinnati, O.
A. W. Osler.....Cincinnati, O.
Wm. Buchanan, Thos. Buchanan & Co.....Cincinnati, O.

John Dimling.....Pittsburg, Pa.
S. Bauer, Hill & Bauer.....Cincinnati, O.
S. P. Egan, Fay & Egan.....Cincinnati, O.
F. X. Black, J. Black & Clawson Co.....Hamilton, O.
H. Mashima, Becket Paper Mill.....Hamilton, O.
Thos. Buchanan, Thos. Buchanan & Co.....Cincinnati, O.
F. C. Schwoerer, Indiana Foundry Co.....Indianapolis, Ind.
C. E. Stewart.....Cincinnati, O.
S. Kahn, F. & L. Kahn & Bro.....Hamilton, O.
H. Beeching, Pfau Mfg. Co.....Cincinnati, O.
Wm. N. Garpside, Diamond Clamp & Flask Co..Richmond, Ind.
S. P. Hostler, Winifred Coal Co.....Chicago, Ill.
Jos. Marsh, Cleveland Fence Co.....Indianapolis, Ind.
J. R. Moore, Moorhead Bros. & Co. Inc.....Pittsburg, Pa.
J. H. Pepper.....Philadelphia, Pa.
Jas. H. Curan, J. H. Curan & Co.....Cincinnati, O.
Frank X. Lang, Newport Iron & Brass Fdry. Co..Newport, Ky.
Charles Bailey, Reliance Steel Casting Co.....Pittsburg, Pa.
A. R. Ludlow, Springfield Mall. Iron Co.....Springfield, O.
Chas. Lange, Buckeye Fdry. Co.....Cincinnati, O.
D. T. Evans, Mt. Carbon Co.....Powellton, W. Va.
Orville Simpson, Straub Mach. Co.....Cincinnati, O.
Charles E. Zimmerman, Eureka Fdry. Co.....Dayton, O.
J. E. Zimmerman, Eureka Fdry. Co.....Dayton, O.
R. E. Mehan, Monterey Fdry. & Mach. Co..Monterey, Mexico.
R. F. Mehan, Monterey Fdry. & Mach. Co..Monterey, Mexico.
A. J. Bauer, Hoefinghoff & Laue Fdry. Co.....Cincinnati, O.
F. A. Klaine .....Cincinnati, O.
E. H. Huenfeld, F. A. Klaine.....Cincinnati, O.
F. J. Spieker, Globe Fdry.....Cincinnati, O.
U. E. Kanavel.....Zanesville, O.
H. J. Gosiger, Eureka Fdry. Co.....Cincinnati, O.
Otto Marmet, Marmet, Smith Coal & Coke Co...Cincinnati, O.
A. B. Trum, Marmet, Smith Coal & Coke Co....Cincinnati, O.
B. M. Meilzeiner, The S. Obermayer Co.....Cincinnati, O.
R. C. Nicholas, with Thos. A. Mack.....Cincinnati, O.
C. A. Treat, C. A. Treat Mfg. Co.....Hannibal, Mo.

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L. C. Rose, L. C. Rose & Co.....Cincinnati, O.
Geo. M. Hahn, Marmet, Smith Coal & Coke Co..Cincinnati, O.
A. H. Tuechter, Bickford Drill & Tool Co.....Cincinnati, O.
F. A. Geier, Cincinnati Milling Mach. Co.....Cincinnati, O.
J. H. Shaffer, Pittsburg Testing Laboratory.....Pittsburg, Pa.
J. J. Foley, J. W. Foley & Co.....Cincinnati, O.
F. Johannigman, J. W. Foley & Co.....Cincinnati, O.
R. J. Kroger.....Cincinnati, O.
Charles Buchanan, Thos. Buchanan & Co.....Cincinnati, O.
Lincoln Haney, The Globe Fdry. Co.....Cincinnati, O.
Wm. W. Hearne, Matthew Addy & Co.....Cincinnati, O.
Joseph Valentine, "Iron Molders' Journal".....Cincinnati, O.
David Black, "Iron Molders' Journal".....Cincinnati, O.
Martin Fox .....Cincinnati, O.
H. P. Deuscher, H. P. Duescher Co.....Hamilton, O.
Louis F. Walter, with Thos. A. Mack.....Cincinatti, O.
A. Cunningham, Luhrig Coal Co.....Cincinnati, O.
C. A. Stevenson, Stevenson, Field & Co.....St. Louis, Mo.
Chas. S. Woodward, Domhoff & Joyce Co.....Cincinnati, O.
M. H. Fletcher.....Cincinnati, O.
Geo. C. Avery, B. F. Avery & Son.....Louisville, Ky.
T. J. Joyce, Domhoff & Joyce Co.....Cincinnati, O.
John Sargeant, Domhoff & Joyce Co.....Cincinnati, O.
J. W. Gardner, Gardner Governor Co.....Quincy, Ill.
Samuel H. Whittaker, Dayton Coal & Iron Co....Cincinnati, O.
W. L. Turner, Matthew Addy Co.....Cincinnati, O.
Edwin McFarland, Matthew Addy Co.....Cincinnati, O.
James A. Green, Matthew Addy Co.....Cincinnati, O.
Lazard Kahn, F. & L. Kahn & Bro.....Hamilton, O.
J. J. Bruce, Sam C. Tatum Co.....Cincinnati, O.
C. A. Truesdale, Wm. Resor & Co.....Cincinnati, O.
E. Kemper, "American Manufacturer".....Cincinnati, O.
A. M. Smith, Marmet, Smith Coal & Coke Co....Cincinnati, O.
A. Hemboldt, Newport Iron & Brass Fdry. Co....Newport, Ky.
Henry Schuh, Newport Iron & Brass Fdry. Co....Newport, Ky.
Eliot A. Kebler, Matthew Addy & Co.....Pittsburg, Pa.
H. D. Erhart.....Cincinatti, O.

Jay Gould, Industrial Fdry. Co.....Cincinnati, O.
Geo. Webb, Industrial Fdry. Co.....Cincinnati, O.
J. R. McFarland, L. Jones & Son.....Cincinnati, O.
F. P. Jones, L. Jones & Son.....Cincinnati, O.
C. H. Domhoff, Domhoff & Joyce Co.....Cincinnati, O.
J. W. Foley, J. W. Foley & Co.....Cincinnati, O.
C. R. Stephens, Moline Plow Co.....Moline, Ill.
Al. Cordingly, Queen City Fdry. Co.....Denver, Col.
Shelby Compton, Niles Tool Works.....Hamilton, O.
Henry Smith, "The Iron Age".....Cincinnati, O.
John Grant, Valley Iron Works.....St. Paul, Minn.
G. H. Palmer, Palmer & Demooy Fdry. Co.....Cleveland, O.
F. J. Patterson, Patterson Fdry. Co.....Cleveland, O.
C. T. Morey, Deere Co.....Moline, Ill.
S. J. Raine, "Post".....Cincinnati, O.
H. L. Matthews, Decatur Mall. Iron Co.....Decatur, Ill.
Rolston H. Goss, "Times-Star".....Cincinnati, O.
J. P. Gardner.....Cincinnati, O.
W. H. Wells, Holly Mfg. Co.....Lockport, N. Y.
B. R. Marchand, Illinois Steel Co.....Chicago, Ill.
A. M. Thompson, Link-Belt Machinery Co.....Chicago, Ill.
C. L. McNamara.....Cincinnati, O.
A. W. Bair, C. M. & St. Paul Railway Fdry....Milwaukee, Wis.
Geo. S. Caruthers.....Pittsburg, Pa.
D. Gallagher, T. P. Kelly & Co.....Chicago, Ill.
C. W. Jackson.....Chicago, Ill.
J. E. Fisher, National Transit Co.....Oil City, Pa.
James Barclay, Deere-Mansur Co.....Moline, Ill.
E. P. Wilson.....Cincinnati, O.
A. Phenis, "Commercial Tribune".....Cincinnati, O.
D. C. Shears.....Cincinnati, O.

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PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

At the meeting of this association, held June 1st, the executive committee reported that the steel casting men, as well as the malleable iron foundries, continue to be very busy, and that it is the committee's belief that the remaining months of this year will be prosperous ones to the foundries and iron industries of the country.

Continuing, the report stated that the demand for good molders is so great that there is difficulty in procuring good workmen. Just how long this difficulty will continue it is impossible to tell, but in the opinion of the committee the only thing to do seems to be that every foundryman shall try and educate his molders and helpers to a higher standard, to the end that the demand may be supplied.

As showing the continued prosperity of the iron trade, reference was made in the report to the Russian Government order to Cramps' for battleships and torpedo boats, amounting in money to many millions of dollars, probably the largest order that has ever been given out by that or any other country at one time, and the orders for 142 locomotives from foreign governments to the Baldwin Locomotive Works, the Richmond Locomotive Works and the Schenectady Locomotive Works, most of which, it is understood, is to go to Russia, to China and to Japan.

After the meeting, J. Harry Pepper gave an illustrated talk on "Recent Developments in Foundry Equipments." Most of the views shown were of pneumatic appliances, including molding machines, rammers, chipping tools, hoists, cranes and sand sifters, many of which aroused considerable interest, and elicited questions as to their power, cost and the time and money saved by their use.

WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday, June 15, 1898, at 7:30 p. m. at the Great Northern Hotel, Chicago, with the President, G. H. Carver, in the chair.

Under the head of unfinished business, Topical Question No. 14, "What is your experience as to the utility and efficiency of flexible shafting for use with grinders on heavy and intricate castings?" was discussed. A contributed discussion of the question, by C. W. Shields, is as follows:

"As for flexible shaftings for grinders and heavy and intricate castings, we have known of so many instances where a small compressed air rotary motor has supplanted flexible shaftings that we were of the opinion that about every one was satisfied that a small rubber hose was cheaper and easier to handle than a flexible shaft. These latter are too expensive to permit of using any but short lengths, and their weight prevents the handling of the grinder to good advantage. The cost of the power would be in favor of compressed air, and a hose pipe can be connected on anywhere or run any desired distance; nor is any countershaft, driving rope or counter weight necessary, using air. So many foundries are now equipped with a compressed air plant, and as compressed air can be used for such a great variety of purposes in a foundry, I hardly think that a flexible shaft would be considered desirable unless in some exceptional case—most certainly not in a foundry using or contemplating the use of compressed air. In addition to operating emery grinders compressed air is used for chipping tools, sand blast, tumbling barrel and hoists, right in the clearing shed, so why not apply this power which is at hand rather than use a flexible shaft and its attendant gearing? Of course, your air plant, if used only for operating a rotary emery grinder, would cost more than a flexible shaft and outfit, but as all first-class foundries now use air or will install an air plant in the

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near future, it seems obvious that it is hardly desirable to consider any other means of operating your grinding machines, particularly where the ease of running one or more hose pipes any distance is taken into consideration."

Mr. Schoff: I suppose that nearly all of you have seen flexible shafting. It is simply a shaft made flexible by layers of wires, the ends of which are solid, with fittings attached; and that is all worked in a case. It has been in use for 20 years for many purposes. We have labored under the disadvantage of having to run the flexible shafting with a rope drive. It has been a source of trouble, and we have discarded it for that reason. Compressed air will be of more benefit to the fiexible shafting than damage. Compressed air can be carried everywhere. Instead of knocking the flexible shafting out of use, compressed air will help us very materially in the way of running it by means of a motor through which the compressed air is applied direct. We make such a motor. It is small and is made on the basis of an oscillating engine. We can mount it on wheels so that it can be carried anywhere, or with an eye at the top so that it can be suspended. By means of a universal joint we can attach the flexible shafting direct and that does away with the rope drive or bearing of any kind. If the speed wanted should be more than the normal speed of the engine, it is easy enough to gear that up. The universal joint is made so that it will bend at an angle of 60 degrees. You can attach an emery wheel and remove it without cutting off power. We think it is the best way to grind any casting that is too heavy to bring to a stationary wheel.

Mr. Carver: Is the motor for compressed air?

Mr. Schoff: It can be run by either steam or compressed air. You can hang this motor or carry it anywhere. One gentleman has asked how long a flexible shafting it is advisable to use. I say a standard, by all means; this is eight feet long. Anything longer than that has a great many disadvantages. It adds to the weight, in the first place; it adds to the cost, in the second place, and it adds to the cost of repairs, as well as the

time consumed in making repairs, in the third place. In some cases it might be better to use a longer one, but we do not advise it. I would like to state that I have seen a flexible shafting in use lately, where its advantages are easier to be seen than any I have seen before. I was in a foundry where they are making large 13-inch Government shells, the inside and outside of which must be concentric. This particular foundry does not bore out the shells. It has arranged a flexible shafting, and the men are becoming adepts at its use, so that they use flexible shafting with an emery wheel on it and clean out the inside of the shell so that it looks as near like boring as if it had been bored, and their shells are accepted invariably. They understand all the difficulties of the flexible shafting and they have experienced all the troubles, they think. They acknowledge that it saves them a great deal of money. In that same foundry they are making a peculiar hard steel that is used as the groundwork of the street railroad crossings and frogs, to which the rails are attached. This steel is so hard that it cannot be machined; the only way they can do anything with it is by the use of emery wheels on the end of a flexible shafting. They have as many as a dozen flexible shaftings in constant use in their foundry.

In regard to pneumatic tools, I will not say anything against them. I understand them pretty well and I know how they are made and used, and I am willing to acknowledge that they have a large use and are good tools, but my individual opinion is that a short time will show that they are very expensive tools to use. If they pay for themselves before they are worn out, they are all right.

Mr. Johnston: Is there any more danger of the emery wheel breaking on the flexible shafting than otherwise?

Mr. Schoff: I never knew of one breaking. We expect to run the flexible shafting up to within and, in many cases, quite the speed given in the various tables of emery wheels by the manufacturers. Another question that has been asked me is about the jumping of the emery wheel. It is a matter of ex-

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perience with the man who operates it. He must get accustomed to it. He must know how light or how heavy to attach it and must not use too large a wheel. We do not advise a wheel larger than six inches in diameter. A larger one is not only too heavy, but the rapid motion of the hand is troublesome to the wrist.

Mr. Orbison: We have flexible shafting run by an electric motor, but we have not put it into use in the grinding of castings, only in drilling. My idea is that it would be a little cumbersome.

Mr. Schoff: Flexible shafting is not heavy. We use the No. 4, No. 5 or No. 6 flexible shafting usually. The No. 6 does not weigh over 40 lbs. complete, and of course a large part of the weight is held at the upper end in either the rope or motor, so that you have in your hand only the emery wheel and a few pounds of the flexible shafting.

Mr. Jones: You spoke of the entire weight of the flexible shafting being 40 lbs. Did you mean a standard length?

Mr. Schoff: Yes.

Mr. Jones: And what is the diameter of the No. 6 wheel?

Mr. Schoff: The No. 6 has its working wheel an inch in diameter. That is surrounded by a case which is covered with leather, so that the leather covering is about twice that size.

Mr. Wolf: We use about 15 flexible shaftings in our works. We use the inch and a quarter No. 8 for the emery wheel. We grind bath tubs and other castings with a six-inch wheel, two inches thick. We grind from the side surface of the wheel. It takes off the roughness from the castings much more readily than grinding from the outside. We have used them for six or eight years with very good success. We use No. 8 because we think it is a little stronger.

Mr. H. G. Carver: What motor do you use?

Mr. Wolf: We connect it to the belting. It is a complete rope drive.

Mr. Thompson: We do not use them in our foundry, yet I think there is one in the machine shop. I do not know whether it gives satisfaction or not. I think it is very expensive to keep up.

Mr. Schoff: That depends very largely upon the kind of labor you have. If the men are accustomed to the use of hammers and heavy tools, they will use a flexible shafting rather roughly. Our experience is that it is not expensive.

Mr. Orbison: We have not applied the emery wheel in cleaning castings. We use the pneumatic chipper exclusively in our foundries. We have only used the flexible shafting for drilling. It is something that I have been thinking about, and think that it is a good thing. I still stick to my previous remark, that I believe it to be a little cumbersome.

Mr. Schoff: Of course it cannot be used interchangeably. It can only be used on flat surfaces.

Mr. Wolf: I would say that in using the side surface we have a two-inch hole in the wheel, and by having the hole so large the surface grinds through the wheel.

Mr. Schoff: We increase the hole to three inches. Of course the center of the wheel will do no work if it is solid.

Mr. Stantial: We are using the flexible shafting, not so much for cleaning castings, as for finishing up light patterns. I do not know what number it is, but I have an idea it is No. 6. We have found it to be one of the most useful tools we have in the shop. We have a great many iron patterns to finish up, and we finish them in much less time with the flexible shafting and emery wheel than by filing and chipping. We have had no trouble whatever with it being cumbersome. In fact, we think it is handy and light. The only trouble we have had has been that of the grindings falling into the bearings of the movable handle and either sticking it so that the handle would not revolve or it would not last any length of time.

Mr. Schoff: Tell your man to throw the handle away.

Mr. Carver: Why do you put on the handle?

Mr. Schoff: Because when one first takes hold of the flexible shafting he uses both hands. When a man takes up a thing like this he naturally thinks it is dangerous. After he has run it with both hands a very short time the handle is lost and he gets along without it just as well, if not better.

Mr. Stantial: Does it injure the shafting at all to use it without a handle?

Mr. Schoff: The only thing to avoid with the shafting is short curves.

Mr. Stantial: We have used the shafting which we have, a year and a half pretty steadily.

Mr. Schoff: We always have three or four of them set up for all kinds of purposes. When one man gets through with it he lays it on the bench and it is ready for the next one. We use a No. 4 altogether in our work.

Mr. Stantial: Instead of tying it down to the floor we hang a weight upon it.

Mr. Orbison: Would it pay to replace pneumatic tools with the grinder?

Mr. Schoff: If you have your compressor plant you will find a great many pieces of work for which it will pay to put in flexible shaftings. I remember once going to the Washington Navy Yard. On the way through the shop I had pointed out to me, away at one side, an old drill press, the stand of which was fastened to the floor. It had two or three arms and looked as if it had been made for about a thousand years. They told me that people came from all over the place to use that old drill because they were accustomed to it and liked it. It is very much the same with any other tool. A man is very loath to part with a tool that he is accustomed to. I do not mean to make that a comparison, because the flexible shafting

is a great deal older than the pneumatic tool. I think there is room for both.

Mr. Orbison: I do not know that we have ever made any close comparison between the cost of pneumatic tools and ordinary chipping. There are some cases of work that a pneumactic tool is not fit for, but that does not apply to everything. In the case of some castings it would be folly to attempt to cut off the roughness with pneumatic tools entirely. We cut a groove with the pneumatic tool and then use a chisel. The two combined are very essential.

Mr. Stembom: If a man knows how to use the pneumatic hammer he can do twice as much work as a man can do with a hand hammer.

Mr. Carver: Another matter of interest that is to come before the association for the benefit of those who did not go to Cincinnati to the meetings of the National and American Foundrymen's Associations, is a report from some of those who did go.

Mr. Wolf: The trip to the Addyston pipe foundry was very interesting. They make the largest water pipes, and it was very interesting to watch them handle the iron in large quantities by the use of dummy engines and cars. At the Addyston foundry they carry the iron in a ladle on a small car which runs on tracks. The ladle holds, I should judge, about five tons of iron. A little dummy engine backs up and takes the car to where the iron is needed, and a large crane raises the ladle and a man turns it by a gear and pours the iron into the molds. It is handled very quickly.

Mr. Jones: I was highly pleased with the trip from start to finish. One thing that impressed almost every one in going there was the fact that while we were there, Cincinnati was practically ours. The entertainment committee did their duty to the utmost. We were royally entertained. I was somewhat disappointed in not being able to take in the leading foundries in the city itself. I was told that there was hardly a first-

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class foundry in Cincinnati; that all the shops were small medium jobbing shops and that the large enterprises there did not have their own foundries. Such concerns as the Lodge & Shipley people hire their castings made outside in one of the dozen different shops, and the Bradford Milling Machine Co., which perhaps make as many engine lathes as any one concern in this section of the country, have no foundry. I noticed, while in front of their plant, I should say in the neighborhood of 150 to 200 lathe beds in the rough. They were piled up promiscuously in the street in front of the works. I went to the Obermayer plant, which we had the pleasure of going through from one end to the other, and which to me was very interesting. I was also among the delegation who went to Hamilton and visited the Niles Tool Works. In their machine shop they are at the present time getting out two lathes for some of the extensive gun-makers in the country. The bed is made in two sections and bolted together in the center. These lathes are to swing 9 ft. from the ways and 60 ft. between centers. I was curious enough to measure the brass bearing in the headstock and found it to be 16 in. in diameter and 28½ in. in length. One point of interest to me was the construction of the largest mill they have yet made. It was to swing 25 ft. They were turning up the bed-plate of it at the time I was there. I noticed a good share of it was made in cores. That piece weighed a little over 15 tons. We went from there and visited a foundry doing nothing but bench work, a part of which was a job of little buttons to be used by carriage manufacturers. We noticed two boys who were putting up 10,500 castings per day, in each one of which they set a nail. One boy did the molding and the other set the nail and closed the flask. This same foundry was owned by the proprietors of the Hamilton Corliss Engine Company. We went over there and visited their foundry. I think I was more favorably impressed with it than I was with the Niles. It is newer and thoroughly modern. They were getting out some of their heavy work. I noticed a 16-foot band wheel. I think the face was something like 40

or 48 inches. The character of the work was excellent. In my trip to the Addyston Pipe Works, I was impressed with the rapidity with which they handled the work and it had never been my lot to have anything to do with a cupola of anything the size of the one they had there. I think it was lined up 8 feet and was 10 feet outside. They were melting 240 tons a day in that one cupola. They had five or six others and all in a line, part in operation and the balance undergoing repairs. It was so hot in there that I could not remain long.

Mr. Thompson: I brought some of these little buttons, Mr. Jones mentions, with me. It is quite interesting to see how cheap and how quickly castings like that can be produced. In order to make this 10,500 in a day a boy would have to set one of these nails every three seconds constantly for $8\frac{3}{4}$ hours. I tried to see how I would get on and I could not do it. All the castings are milled in the morning and in the afternoon they are packed in barrels and shipped off so that the entire product is disposed of in twenty-four hours. Speaking of the Hamilton-Corliss Engine Works it also appeared to me that the management of that foundry was very well indeed. They were making cylinders and beds. All the facing is mixed under the supervision of the foreman.

The new sand is dried in the oven and put through a mill and then put through a machine-riddle mixing it with the facing. The castings are put through a tumbling barrel and come out sufficiently true not to require tumbling. In making the outside of their large band-wheels, while we adopt the dry sand core system they make them in green sand and while the inside of the mold is sticky dry the outside is not so, the face of the casting is very sandy. In some machine shops that would probably be objected to on account of the action of the sand on the cutting tool, making it necessary to have it sharpened or ground very frequently, but they seemed to think that there was no tendency toward dulling the tool. It is a matter of opinion as to whether it is economical to spend more time in the foundry in producing the smooth effect of the surface or putting in the

extra time in the machine shop. In the Niles Tool Works the foundry appeared to me to be a great deal larger than was necessary for use, and yet I believe they were sending casting outside to be made. There was a large amount of space occupied by unfinished castings which seemed to have lain there several days, and that with the amount of space not used, seemed to leave but one-fourth of the shop for actual use. Out here we would think the expense of a foundry having so much room and doing so little work would knock it out of the market in competition, but no doubt in a foundry of that size where they are making such large castings, the castings have to remain in the sand a considerable time, and this would leave a large amount of the space unoccupied.

Mr. Johnston: There was one paper read by Mr. Putnam which I regretted did not receive more consideration, as it would have been interesting to foundrymen with or without technical training. This paper dealt with the "Inspection of Castings," and was a paper which could have been discussed more, and I think it might be a good thing to have before our meeting some evening. As far as the entertainment committee was concerned, it did its best, I know. I enjoyed the convention from beginning to end, but would have enjoyed it more if there had been more time devoted to the discussion of the papers.

Upon motion, duly seconded, the secretary was instructed to have the paper of H. M. Ramp, "Trolley Systems, Their Value and Cost," and that of E. H. Putnam, "Inspection of Castings," which were presented at the Cincinnati convention, read at the next meeting for discussion.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The Pittsburg Foundrymen's Association held its last meeting of the year Monday evening, June 27, at the Builders' Exchange. Discussion was had on Mr. Stupakoff's paper of the last meeting on "Foundry Appliances." Mr. Stupakoff made some supplementary remarks in the course of the discussion, which was also participated in by a number of members.

Dr. Moldenke submitted the report of the committee on a central agency for preparing and distributing standardized drillings. It referred to the favorable action of the American Foundrymen's Association at Cincinnati on the memorial from the Pittsburg Association and the appointment of a committee of seven to carry out the work, Mr. West being chairman, and Mr. J. Scott and Dr. Moldenke the two other members thus far appointed. The report added that while the committee's labors really ended with bringing the matter before the Cincinnati convention, it had continued to push the project in the interest of the trade, and was able to report that the outlook warranted the preparation of two standard samples, one of foundry and the other of Bessemer iron, both being under way. The committee added that the work was now turned over to the national committee, and asked that it be discharged. This was done, with the thanks of the association.

The following paper by Thos. D. West, on the preparation of standard castings, was read, after which adjournment was taken to the fourth Monday in September:

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MAKING A LARGE CASTING.

By THOS. D. WEST.

When the writer first formed the idea of a National Agency for distributing standardized drillings, as outlined in his paper, "Need of Greater Uniformity in Pig Iron Analyses," presented to this association last April, he knew that to make this practical a body of cast iron weighing from 400 to 500 pounds, free from all sand grit or slag, would have to be obtained, as no chemist would accept a sample for standardizing purposes that contained any of these impurities. It was also known that many would question the practicability of making a casting of 400 to 500 pounds that would be absolutely clean, solid and of a homogeneous grain, so that when drilled or turned it would give a uniform sample for standardizing purposes. As a rule, chemists have found it difficult to obtain samples of even 25 pounds weight that would be reliable.

To obtain 300 pounds or more of absolutely clean and uniform drillings or turnings involves experience in heavy founding, but like all else, when once known, it is easily achieved. The plan is as follows: A mold of dry sand for the outer body and a dried core for the inner, are made as seen in the plan and section view at Figs. 1 and 3. The construction of the mold explains itself. The secret of getting a clean, solid casting lies mainly in the method of gating and pouring it. At A is a gate leading down to the bottom of the mold with an inlet at D. The round gates B, seen at the top of the mold, are placed about 4 inches apart and are ½-inch in diameter. A riser is seen at E. In starting to pour the mold, the hot molten metal is directed to drop from the ladle into the basin at the point marked W in a way that will permit it to flow gently down the gate A and enter the mold at D. When from 30 to 50 pounds of metal has entered the mold to prevent the bottom being cut by the top gates a quick turn of the ladle empties a large body of the metal into the pouring basin, quickly filling all the gates at B; this then drops the metal down upon that which is rising from

the stream flowing in at D. This action is kept up until the mold is filled and the metal runs out at the riser E. After this point is attained, the pouring is slackened and a steady stream maintained until from 300 to 500 pounds of metal has flown through the riser E to run down the incline seen at S, into the scrap pig hole X. The effect of causing such a large body of molten metal to flow through the mold, by making it enter the gate at A, is to keep up an agitation after the mold has been filled, which in turn will be most beneficial in causing the metal in the mold to mix well and counteract variations in structure that might otherwise take place. The metal dropping from the top gates B causes a disintegrating action, cutting into a fine dust any dirt that might accumulate upon the surface of the rising metal and which, were it not thus chopped up, as it were, into fine particles, would gather in large lumps, to be caught and held fast on the mold walls, with the result that dirt spots, etc., would be found in the casting, when its skin is removed by a drill, lathe, or planer. Again, the fact that the metal drops from the top of the mold, besides entering at the bottom, causes the top body of the rising metal to be as fluid as that at the bottom, which is also beneficial in causing all scum and dirt to float upward with the metal, to the top of the mold or "riser head." Where metal fills a mold all from the bottom, it becomes rapidly duller in rising to fill the mold, an evil which will be readily seen. The writer, in the capacity of both journeyman and manager, has made almost all kinds and weights of complicated and difficult steam, gas and hydraulic cylinder castings, after the plan of gating shown in Figs. 1 and 3, and can say that whenever this plan of gating could be adopted, he has no recollection of ever having seen a bored surface (after the riser head was cut off), that displayed a dirt hole the size of a pin head, so perfectly clean and solid were such casts when finished. The writer is not alone in experiences of this character, as others familiar with heavy founding, who have followed the plan herein outlined, will agree with the above statement. While this article is intended mainly to show the practicability of obtaining 300 or more pounds of uniform and clean

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drillings or turnings for standardizing purposes, it incidently deals with practice that will be of use to the general molder or founder who may not have had experience in casting steam, gas or hydraulic cylinders.

Fig. 2 shows a section of the casting obtained from the mold, with the exception of four lugs, cast on to assist in holding the cylinder in the lathe while it is being turned. It will be well at this point to state also that there is no difficulty in obtaining

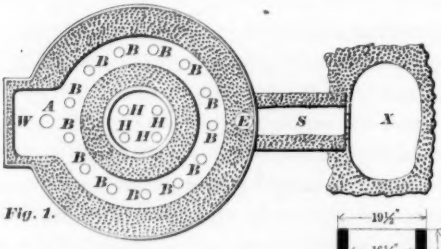

Fig. 1.

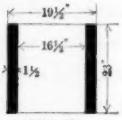

Fig. 2.

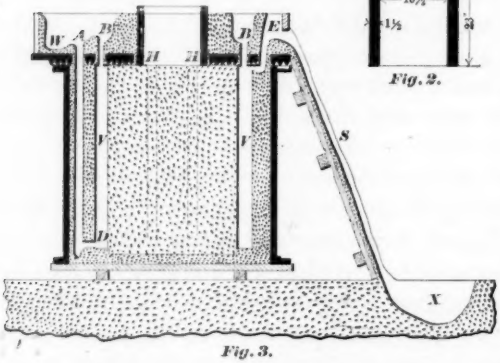

Fig. 3.

castings running into tons, which might serve for standardizing purposes. The plan of securing these turnings or drillings is first to take off about ⅛-inch from the outside surface. These first turnings are cast aside, as they will contain more or less scale and dirt formed on the face of the casting by the fusing action of the molten metal upon the sand forming the face of the mold. After this surface has been turned off, and all the debris

removed carefully from the lathe, the cylinder is turned until about ¼-inch thickness of an inner shell remains. The turnings obtained from the body after the ⅛-inch thickness is removed are the ones taken for standardizing purposes. It should be stated that about one-half inch thickness at the bottom and the "riser head" of two inches at the top are not disturbed, so as not to have the scale on the bottom of the casting or any dirt that would be collected at the top end, mixed in with the turnings obtained from the inner body of the casting. After the turnings have been thus obtained, they are passed through a 40-mesh sieve and thoroughly mixed, when they are ready to be analyzed, or standardized.

The molding and casting of this work is personally overseen by the writer. Two castings are being made, one of Bessemer and the other of foundry iron. The first casting is at this writing in the hands of Prof. C. H. Benjamin, at Case School of Applied Science, who is to manage the procuring of the turnings and the other work pertaining to distribution. Prof. Smith, of the same college, is to have charge of the analytical work. The reputation of both these gentlemen is a guarantee of the reliability of results. The silicon, sulphur, phosphorus, manganese, and both carbons will be determined and standardized. The methods used for determining the analyses will be furnished with the samples gratuitously to any desiring them. For the sum of $5 a subscriber will be furnished one pound of the drillings of all one kind, or half of each, as he may wish it, delivered to him. One pound should furnish enough material for 36 complete analyses or at least 200 separate determinations. At this writing, June 23, 1898, 30 firms comprising blast furnaces, foundries and steel works have sent in their orders for one pound of standardized drillings, which will be ready for delivery in a short time.

The manner in which this project was received and endorsed by the convention of the American Foundrymen's Association at Cincinnati, the fore part of this month, indicates the necessity and value of having one source from which all could obtain standardized drillings, instead of laboratories doing this work for

themselves, as many do. It is hoped that before the close of this year, most of the laboratories dealing with cast iron, whether makers or users, will be subscribers to this central agency. Such an achievement is sure to lessen many of our present grievances and losses due to the lack of a national standard to assist the chemist in checking the results of his personal work, his methods or his chemicals.

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The following paper, "Stripping Plate Molding Machines," by E. H. Mumford, of the Tabor Mfg. Co., Elizabeth, N. J., was read at the Boston meeting of this association:

STRIPPING PLATE MOLDING MACHINES.

The development of the modern molding machine may be said to have extended its use while specializing its offices. For illustration, most ingenious and efficient special machines mold nearly all kinds of gears with accuracy and speed, thus carrying the use of molding machines into gearing in a way that would have been impossible to the general machine, built for the ordinary demands of molding; yet the machines have no application to the general run of work. The same may be said of machines for molding pulleys, and of other special refinements of the molding machines to suit special cases. Having to do, in our practice, with machines for general work, aiming at maximum speed with greatest perfection of molding, it is the intention of this paper to deal with the problems occurring in this field.

The builder of molding machines to-day, if he cares for anything more than "getting his machines in"—perhaps to come out like a blunt axe struck into rock maple—studies, if not every individual casting, to fit a machine to it, yet the import of each casting to the performance of the machine, and adapts his machine to the work made up of individual castings in any shop he enters.

It is, therefore, impracticable to speak, except in a most general way, as to what is the limit of machine molding in any direction. There has been chosen above for an illustration of the special application of molding by machinery the segment gear molding machine. Obviously it will not make anything else, and, per contra, no other machine will mold gears, especially wide spur gears, as well, unless from an entire pattern, which, in stripping plate machines, cost at the rate of special cut

gears, two gears, an internal and a spur gear. In fact, in general, a job of gear molding is well out of the stripping plate field, especially so when we come to rather flat bevel gears, as these must be rapped just in the right way, not too much, to draw the teeth at all, the stripping plate being without effect except at the ends of the teeth. A small skew bevel gear casting which I have here will illustrate my meaning, and will, I think, be acknowledged impracticable with a stripping plate. Most gears now molded on stripping plate machines, except the teeth are excessively closely pitched, can be handled at much less pattern cost in vibrator machines than in those employing the stripping plate.

There are only two things to be said uncomplimentary to the stripping plate, and they are facts. Otherwise the stripping plate is an ideal method of molding work not having excessively sharp detail on pattern surface. The two facts are that stripping plate patterns cost a good deal, and that they wear out rapidly.

All sorts of attempts have been made to lessen the cost of making up this wear, such as wooden stripping plates, iron plates with babbited edges next the pattern, etc., and these are good as far as they go, only that they leave out of the count the wear of the pattern itself, which, of the two, wear of plate and pattern, is far the more serious in its result. When your stripping plate is worn, it is time to look to your pattern, and the refitting of plate alone is a good deal like the practice of closing brasses on a pin. You take out the slack between plate and pattern, you take away the knock at the pin. Your pattern keeps approximately the same shape, your pin may stay round, but both pattern and pin get smaller.

A pattern for a brake shoe, a tie plate or a sash weight, will stand this longer than a pattern for a machine part, but they all become thinner as age creeps upon them, and we all know how cheap and easy it is to mend a roof and keep it leaking, patch a boiler and miss it entirely some day, even to keep a minister and lose a congregation. As an illustration in point,

I would quote from a letter just received from John C. Meloon, the able mechanical superintendent of the General Fire Extinguisher Co., at Providence. Mr. Meloon has been making the brass castings for the yokes and bodies of the Grinnell automatic sprinkler for years on stripping plate machines, which he has recently abandoned. It occurred to the writer that Mr. Meloon's experience with stripping plate patterns in constant use would be more conclusive than anything he might cite generally from observation, and Mr. Meloon has kindly placed him in possession of actual figures. He says:

"In making our sprinklers, we have taken from our draw plate machine 256,000 molds, and, in taking this number of molds from the machine, we have used up four plates, making an average for each plate 64,000 molds, and that is getting out of the patterns all that was possible for us to get. The last molds we took from this machine were far from being satisfactory, due to the excessive wear on the patterns and the draw plates. Our work commenced to be unsatisfactory after we made the first half of the 64,000 and continued to grow worse until we were obliged to renew them."

These patterns were in continual use, the patterns of brass, the plate of cast iron. To illustrate what these figures mean, we will consider another machine, or rather a pair of machines, using split brass patterns fitted to flat plates, and drawn by a vibrator. Each of these machines has a set of patterns on it, and each is run by one man. One man makes copes and the other man makes drags, so that each set of patterns is drawn half as many times as in Mr. Meloon's machines, for the same number of molds. These men have averaged for a year now 1,800 molds per week, setting 12 cores in each. This, as far as these patterns are concerned, is equivalent to 900 molds from Mr. Meloon's patterns. $32{,}000 \div 900 = 36$ weeks approximately, or about 9 months, when stripping plate patterns would have begun to give bad work. Yet the joints of the castings from the split patterns on the vibrator machine are as good after a year's run as they were at first, and will be after 10 years' run,

the only wear shown by the patterns being from an excessive use of a brush in cleaning, which has rounded some corners on tops of same. The joint is where the worn stripping plate shows its hand. When a stripping plate pattern is played out, both it and the plate are scrap, generally, and a few figures from actual practice will be interesting.

Ninety-six sets of stripping plate patterns were under consideration. Competitive bids for supplying them were opened. In round numbers the highest was $9,000, the lowest $7,000. It was decided to put in vibrator machines, and split patterns on solid plates. One hundred sets of patterns were made ready for the machine, plates, patterns and all, and the cost ran inside $2,250. Incidentally, it may be noted that, in this case, the patterns and the machines to use them, yes, and the air compressor to run the machines, were all started running regularly for less than the stripping plate patterns would have cost—very much less.

Not an unimportant element in the difference of cost is the ease with which split patterns may be fitted to the plates in perfect "match." Again, I would quote from Mr. Meloon, who says: "We have put on plates five sets of patterns in one day, when there have not been over six patterns in a set. This does not include the making of the wooden gate and finishing up the metal one, and drilling and screwing it on to the plate. This requires from four to five hours to do. Of course you understand that if we plated only one set of patterns at a time, it would require more than one-fifth of this time, but by carrying along several sets at a time, there is a considerable advantage."

The figures given above by Mr. Meloon assume the patterns ready to go on the plates, and the plates planed ready to receive them.

Independently of costs of machines and patterns, some queer things happen in foundries using molding machines. On any machine, from the squeezer up, not all the gain is found on the machine itself. Like a good neighbor it raises the standard of the community. Machines of all kinds have had the

effect of stimulating to greater effort, especially to an expansion of the "day's work." In fact, a machine can be seen within a thousand miles of Boston, in a shop with smaller machines, which has never been started, the work it was purchased to do being still performed by hand. Yet the owner of this machine is perfectly satisfied with it (you see the machine has not had to work into favor, as is the lot of most molding machines), and he considers this machine, which cost $5,000, one of the best investments he ever made, so great has been the gain in output from the floor molders under the influence of the idle machine, and its unspoken and unaccepted challenge to greater speed.

This is one way of using a molding machine, but there are others. In fact, if the builder of molding machines could ever tell in advance how his machine would be used, sometimes he would build it, and sometimes he would not. For example, there's one of our machines which has never been fitted with proper sized flasks, in a shop where it is run by one man who gets about 30 to 40 flasks with two three-inch plugs for stop cocks in each, hence has two cores to set. In another shop such a machine is run by two men who set eight cores for inch elbows, and make 320 flasks per day. This is merely a difference in shop spirit, but there are other elements in the use of molding machines than the will which impels the deed. There's the old question of Mahomet and the mountain. As the quantity and size of work increases so does the mountain of sands and flasks; and the point is soon reached where the mere handling of material is as important as the speed of molding. Unquestionably the use of a sand conveyor increases the speed of working a machine, if the conveyor is arranged to properly fill the flask, inasmuch as it may save the operator's time. This, however, is not the solution of the whole problem. When flasks reach the size where a crane or hoist of some kind is needed to handle them, and men who might be employed at the machine are momentarily required for the crane, it becomes a question whether it pays to carry everything to the machine, and then carry it all away again.

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These conditions are most frequently met in cases where flasks are barred and patterns are deep. In such cases, it is impossible to put the sand in so that it will fill up under bars, or ram it by any kind of machine so that deep pockets will get the same effect in ramming as shallower areas, nor is there the least ramming under the bars. The mold must be to such an extent tucked, gaggered and rammed by hand that putting it under any machine ramming is often perfectly inutile except to deceive the fatuous champions of expensive machines for this purpose. Just where it pays to stop machine ramming it is hard to say. As a rule, large machines are suited to special lines of work, and the nature of the work must determine the machine.

Among the most efficient machines in use are machines fitted with either vibrator or stripping plates, mounted on wheels or handled by hoists, on which all the ramming is done by hand, the machine simply drawing the patterns. These machines are generally of comparatively large area, are of light construction and much more readily moved once as work advances than sand and flasks can be moved twice, to the machine and away again. In some work, the sand in pockets is so deep that it is hopeless to attempt to draw patterns down, and have the sand stay up. For such work very efficient machines are made to roll the pattern plates over and draw the patterns up as in hand molding.

So we see that, in molding by machinery, as in any other manufacturing process, the tendency of the age is to suit machines to the work, and the most successful machine, from the machine builder's point of view, is the machine which, though built for general use, yet embodies elements so well designed as to enable it to cope with work of any reasonable difficulty, and let it be understood that nothing in this paper is aimed to prejudice against the use of stripping plates where such are advisable. Our company still builds stripping plate machines occasionally, and it has been the sole motive of the writer to give to you, unbiased, the best light we have through the smoke and dust of the foundry. There are, finally, some facts which it

is well for not only the user but the seller of molding machines to keep in mind, and these may be summarized by a very poor adaptation of a familiar aphorism:

You can mold some kinds of castings on all machines,

You can mold nearly all kinds of castings on some machines, but

You can't mold all kinds of castings on any machine— as yet.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

THE FOUNDRY.

R. H. Palmer writes an article on "Straightening Crooked Castings," which touches a subject of interest to many foundries. The following selections will show the trend of the article:

"The foremen of jobbing shops often have castings to make from patterns that have been made by a carpenter who knew nothing about pattern making, but was told by his employer to make something in a certain shape, and who honestly believed he had made a first-class pattern. Had he heard some of the compliments paid him when it was being molded, it would have opened his eyes.

"Especially is the above true of building work. Going into a foundry a few days ago I saw a man making a column from a pattern well finished, but it was costing to mold $1.85 per column, where I have had the same molded for $1.50, for the reason my pattern was made to mold, the other by a man who neither knew how to or what parts to halve of the pattern to mold to advantage, let alone the right amount of draft.

"He made it as he wanted it to look after it was made, yet that builder could see no reason why he should alter the pattern or pay for altering, and he was even striving to obtain his castings a little cheaper—a little give and take on both sides; a little explanation and trying to understand and helping each other and both would be money ahead.

"Again in building work but few patterns are made straight. If molded straight, pilasters have an unpleasant way of coming up on the ends to look you in the face, and if they do there's a nice job to straighten; and let me say here, I think the temperature of the iron when pouring has a great deal to do with a casting's crooking. In a number of cases where a lot of castings were to be made I found some castings, some 10 feet long crooked all the way from three-quarters of an inch down to three-eighths of an inch, the casting varying so, I found in looking into

the matter that some which were poured rather too slow, or with the temperature of the iron pretty well down, would crook more than those poured hotter, so by watching a little I soon found those poured about so hot and molded three-eighths of an inch crooked came straight.

"I have seen a number of times a man take a casting and heat it and pile on the pig iron and provide no bearing in the center for the casting to stop at when it had gone down far enough, and so it would keep going until he said it was crooked more the other way, and because he had nothing to stop it and it had gone so far below the straight line he thought it could not come back, but on cooling off, the casting would have the same old crook, for it would come back to its original crook. Whereas had he provided the center bearing for it to stop at and heated it red hot it would have stayed there.

The main point in straightening castings is to get the casting to be operated on hot enough if fire is used for straightening."

An illustrated article, showing the "Molding of a Tea Kettle," is contributed by J. R. Douglas, and concludes as follows:

"In our experience we find that soap stone facing, works well on this class of work, as it will not run or make a cold shut casting. We also use cores to form the holes in the lugs, as this is cheaper than boring same. The main thing in molding tea kettles is to vent the spout and core of tea kettle well around the anchor. The sand should be of about the same temper as that used for stove plate and if anything, a little on the dry side."

Writing of "Foundry Office Work," "A Foundry Clerk" says:

"A pay roll without classification will take just as much time to finish as one with, and I have often wondered why this is neglected in some places, there is not the least so-called monkey work about it, as the practical man will admit. A well made up pay roll is worth storing away, no doubt once in a while it may be taken from the shelf for reference, the same as the foundry sheets, the former are records of production the latter will serve as a record for wages."

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"Brass Foundry Practice," by K. K., goes into details connected with that part of the foundry, from which we reproduce the following:

"Let us suppose that a concern in the business of manufacturing steam engines and heavy machinery generally, has decided to establish their own brass foundry. The more staple part of their work will consist largely of bearings, key heads, stems, etc.

"Orders will be constantly coming in on these articles and although the patterns are of such a character that we cannot 'gate' or match-plate them, we can rig up for them so as to save considerable labor. Take the bearings for example, they are generally cast in halves, and we can put the two halves in one flask, and run them with one sprue. Some are 'babbitted,' and some are solid, but they are all cast bearing down, and are wholly in the cope. Consequently it will pay us to construct special flasks for these things with a very deep cope and a shallow drag, and varying in size to suit the different sizes of patterns. If we make these flasks of iron, strong enough to withstand hard usage, they are going to be very heavy, especially for the larger patterns. Experience has taught us that wooden flasks are best in this case. The copes should be deep enough to allow of from 3 to 5 inches of sand, over the top of pattern, according to their size, so as to get the pressure requisite to obtain a perfect casting. For all flasks to be handled on the 'tub' or bench, use 2-inch undressed pine, make them square and put bars across the ends of the cope for handles so that one man can lift them. Bind iron strips on the top edges, to prevent burning out when the pot is rested on the top while pouring, and pin a row of nails inside at the joint to prevent such a thing as a 'drop out' when closing. No bars will be necessary except in the larger sizes. The flasks to be used on the floor should in regard to handles be made the same as any other wooden floor flasks as they will be handled by two or more men in lifting off, etc."

In "Cast Iron Notes," W. J. Keep writes the following under the heading, "Chemical Analysis of Pig Iron:"

"I had a talk to-day with a man, which brought out many interesting points. The irons under consideration were Southern. I claimed that a No. 2 foundry iron should contain at least 2.25 per cent of silicon, a No. 1 soft iron 3.00 per cent and a No. 2 soft nearly as much. That less silicon than that would lower the grade and should be sold for a less price. That we must have the silicon, or we did not want the iron. I know of a case where a No. 2 Southern pig iron contained only 1.25 per cent and another which was sold for a No. 2 soft contained but 1.25 per cent of silicon.

"The conversation at once drifted to the question whether with the rapid running, Southern furnaces could make pig iron with the silicon anywhere near what it nsed to be, and the opinion was that low silicon was to be the rule, and that the necessary amount must be added by softeners containing from 5 to 7 per cent of silicon. The only way to compel the furnaces to make iron that will contain the silicon that they are represented to contain is for the founder to have analyses made of the irons that he receives.

"Some irons will make castings with a skin so hard that it is about impossible to cut it, and yet the casting under the skin is exceptionally soft, and increasing the silicon sometimes increases this surface hardness. The only help is to find the iron that causes the trouble and use so little that this peculiar influence cannot be felt. When silicon is spoken of as the controlling element, it is taken for granted that the other elements are what are expected in good iron. The fast running of modern furnaces produces pig iron with low carbon as well as with low silicon. Such iron is not at all suitable for a foundry iron.

"It would be very satisfying if we could without materially adding to the cost know the chemical composition of the iron we use. Lately we have heard much about chemists using uniform methods. This is very desirable; but as applied to cast iron, the variations in results due to analytical methods is very small, when compared with the variation in the composition of the iron itself. Pig iron is not a chemical compound, but an imperfect mixture of

quite a number of metals and metalloids, which have different freezing points and different weights. In solidifying, some parts are fluid and run out from among other parts and when cold there is a great lack of homogenity.

"Drillings from a hole, or from a large number of holes, may not represent those that could be taken from other parts. Unless the one who obtains the drillings is an expert he will allow sand to be mixed with them. An analysis from drillings free from sand will give a close approximation of the chemical composition of the iron from which the drillings were taken. It hardly seems as though the chemists, or their present methods, were to be complained of in analysis of cast iron. However much the melted iron is mixed after being taken from the furnace, in the distribution to the ordinary pig bed, and more especially during the solidifying of the iron, the location of the different elements in the mass will be so very irregular that drillings will never give more than a close approximation. There should be no sand allowed to get in, because the method of taking out selected grains with a magnet will not pick up the non-magnetic particles. It is not certain that the bits of iron cut out by the drill, and which the magnet picks up, contains as much of the non-magnetic elements as the dust and graphitic flakes which have fallen out of the spaces between the grains.

"Cast iron will always be a heterogeneous mixture, and a chemical analysis will always be an approximation of its composition. But this is close enough to use in making mixtures in foundry practice. The lack of uniformity in cast iron analyses does not necessarily result from inaccuracy of the chemist or of his methods, but from the uneven character of the pig iron. In steel, which is vastly more homogeneous than cast iron, the determum of various chemists vary very little."

IRON AGE.

Albert Ladd Colley, in the issue of June 2, has an article on "Sampling Pig Iron for Analysis," in which the author writes extensively of the different methods employed in obtaining samples

of pig iron, supplementing the same with a large number of analyses. He concludes as follows:

"The instances which have been cited showing the non-homogeneity of the different beds of a cast of iron prove that a customer cannot justly claim from the analysis of a single pig taken from each car of iron received that the furnaceman has failed to keep within the chemical analysis agreed upon, and it is equally evident that unless the furnaceman takes at least three samples of each cast of iron he cannot maintain, in case of a controversy, that in the shipment of each cast of iron he has lived up to the chemical specifications of his contract, much less when he does not take the trouble to sample each cast. The writer knows of a case where a furnaceman had the hardihood to claim that the customer's complaint that the sulphur was over the guarantee, when based on the analysis of three pigs from each car, was unjust, when future developments showed that at the furnace only one cast each day was analyzed for sulphur.

"If a contract requires the shipment of an iron of a certain average analysis the customer's sample of each car should consist of carefully mixed fine drillings from at least four pigs. A better form of contract for the customer's interest is one specifying that no iron shall exceed a certain limit of silicon, sulphur, etc. In this case separate analyses of three pigs from each car will be a better check than the analysis of a sample of mixed drillings. In either case pigs of an average size should be selected and uniformly fine drillings obtained, care being taken to prevent sand from the surface of the pigs or oil from the drill press contaminating the sample.

"Catering to the increased demand for iron of guaranteed chemical composition, sales agents freely offer to furnish 'analysis cards' with each shipment of iron. If these analyses are made on representative samples of each cast, and if where portions of two casts are loaded on a car care is taken at the furnace to select casts of similar composition, then the analysis cards are of more value to the customer than his own analysis of pigs selected at random from the cars on arrival; but where, as is often the case,

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the furnace analysis is made on carelessly taken samples, the cards are misleading and only serve to prejudice the customer who realizes the practical economies resulting from the use of irons within certain known limits in chemical composition.

"Sales of iron with no other guarantee than that it shall be of a certain grade are growing fewer each year. The market improvement in the uniformity and quality of all kinds of steel is largely due to the use of iron of known chemical analysis. The recognition of the value of chemical analysis as a basis for foundry mixtures has added chemical specifications to many contracts for foundry iron, and in the manufacture of muck bar both economy and improvement in quality has resulted from the use of low sulphur mill irons between narrow limits in silicon. In these days of close competition the furnaceman who invites inspection of his methods of sampling, analyzing and loading his iron will in the long run retain the best trade.

"The greatest care should be exercised to avoid the errors due to want of homogeneity of pig iron when preparing a sample for distribution among different chemists as a check of the accuracy of their analytical work. It may seem unnecessary to protest against checking two chemists by sending them different pieces of the same pig, yet this has been done. Even a small lot of pig iron drillings, if coarse, cannot possibly be subdivided to give identical samples to two or more chemists.

"In the preparation of standard samples of cast iron the size of the piece should be limited to avoid segregation, and preliminary analyses should be made to determine whether this has been successfully accomplished before the casting is set aside to be used as a standard, and, finally, no pains should be spared to obtain uniformly fine drillings or turnings.

"The need of standard methods of analysis of iron and steel has long been recognized, and many chemists engaged in this line have cheerfully devoted much of their time in endeavoring to bring about this desirable end. Much progress has been made since 1888, when Prof. J. W. Langley suggested the appointment of an international committee, and with the impetus which has

recently been given to the systematic comparison of analytical methods by the establishment at Zurich of an international laboratory for the chemistry of iron much may be expected in the near future.

"In the application of chemistry to technical operations all efforts to improve analytical methods will be largely wasted unless accompanied by an equally earnest effort to secure more uniform and logical methods of sampling. There is now a vast amount of skill and precision daily wasted in the iron laboratories all over this country in the careful, delicate analysis of samples which are not representative, and false and often very expensive conclusions are drawn from these misleading results.

"Furnacemen, foundrymen and steel works who employ poorly paid, self-taught chemists, whose careless and inaccurate work is largely responsible for the prejudice against chemists still existing among practical men, and who can never be made into chemists by the existence of standardized drillings, will probably never awake to the necessity of representative sampling. But at iron and steel works where accurate chemical work is appreciated, and in a measure paid for, reforms in sampling can be accomplished if managers can be made to realize the extent to which unrepresentative sampling may affect the practical value of their chemists' accurate work.

"Improvement is needed in the methods now used in sampling all the materials usually analyzed in an iron and steel works laboratory, but the writer in this article has only asked attention to the sources of error in sampling pig iron, hoping that the American Foundrymen's Association in indorsing the plan for distributing standardized pig iron drillings will also take favorable action in the equally important matter of adopting more representative methods for sampling pig iron, for both improvements are necessary to make chemical analyses of greater practical value, which is the ultimate object desired by all."

IRON TRADE REVIEW.

Richard Moldenke writes the following letter to this journal, commenting upon some statements appearing in a former issue, which were printed in the A. F. A. Journal for June:

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"In your issue of May 19, a New York State foundryman cites another instance of the anomalous conditions confronting us daily in the foundry business. He states that he has two grades of iron of the same brand, one a No. 2 and the other a No. 3. They differ in total carbon by only .20, and in graphite .15 per cent. If we grant that the chemical analysis of each is correct, we have here an excellent argument for discarding grading by fracture. With 3.50 per cent total carbon, a variation of 20 points is not a serious matter, and as the other constituents, graphite excepted, are practically identical, there can be but one plausible explanation for the variation in fracture observed. The metal graded as No. 3 was evidently cast hotter, and therefore showed a greater chilling effect than did the No. 2. Both irons could have been interchanged readily in the mixtures without detriment to the work produced. The question is next asked: 'What effect does the high combined carbon have on the high silicon?' This should be reversed and modified as follows: 'What effect does high silicon have on the carbons in iron in general?' The answer would be, for equal casting temperatures the higher the silicon the lower the combined carbon (within limits), and the higher the casting temperature the higher the combined carbon.

"The last statement that 'the claim of strength rests on a combination of low silicon and low combined carbon,' while appearing contradictory, as low combined carbon means soft iron, has some truth in it. Let us discuss this more fully: Strong iron, as distinguished from hard iron, may be said to be iron with high tensile and bending strength, but capable of machining without too much difficulty. This grade of iron is obtained by keeping the silicon down, say to 1.75 per cent; for high silicon iron, while soft and easily machined, is weak. Low silicon iron gives close-grained, strong castings, which if poured at as low a temperature as possible will not contain an excessive amount of combined carbon. The desirable qualities of a soft, light, high silicon iron casting will not be found in this material; for, to obtain strength, ease in machining must be sacrificed; and the solution of the problem of obtaining great strength combined

with convenience in working is to be found in the malleable casting.

"When, however, this degree of strength is not required, and it is essential to have a thin casting which can be machined readily, a high silicon pig may be used, and steel scrap added to reduce the total carbon, thus leaving less graphite to cause planes of weakness in the resulting product. Iron of this kind must be well mixed before pouring. It is apt to be full of gas and hence a very little ferro-aluminum or ferro-manganese stirred into the ladle will be found beneficial.

"Finally, I am inclined to be a little skeptical regarding the correctness of the last pig iron analysis given. An iron having only 1.87 per cent of silicon should have more than .15 per cent combined carbon, unless indeed the sample was taken from the very center of the pig, in which case the application of Dr. Colby's recent excellent article on sampling pig iron would be self-evident and highly beneficial. I would also like to hear what foundrymen have to say on this interesting subject of strong and yet readily workable irons."

Malcolm McDowell, referring to the same subject, writes:

"I note the communication of a New York foundryman in a recent issue of The Iron Trade Review, and his question as to the use of the two irons he mentions, the No. 2 showing 3.25 per cent graphitic carbon .25 combined carbon, 2.50 to 2.75 silicon, .60 to .70 phosphorus, .015 to .03 sulphur, .50 to .60 manganese, and the No. 3 analyzing 3.40 graphitic carbon, .30 combined carbon, 2.56 silicon, .51 phosphorus, .032 sulphur and .45 manganese.

"The principal difference between the two grades of metal referred to is the difference in the scrap carrying capacity. The particular relation the carbon has to the iron in the pig metal, combined or uncombined, makes but little difference; nor does the fracture cut much of a figure. The value of the pig metal depends upon its constituent elements, which affect the relations that carbon has to iron in the casting. It is the amount of silicon, phosphorus, sulphur and manganese that affects the carbon's

relations to the iron, some forming combined and some forming graphitic carbon. If we take the No. 2 iron, and leave the carbon out of the question entirely, the total amount of silicon would be 2.65; phosphorus, .65; sulphur, .03, and manganese, .55. The difference in favor of the No. 2 in silicon is .09, in phosphorus .14 and in manganese .10, while the No. 3 iron runs higher in sulphur, which is to its detriment. The No. 2 pig iron would carry more scrap than the No. 3 in proportion as it has an excess of silicon and phosphorus, and the manganese would increase its strength."

THE TRADESMAN.

Writing of the "Effect of Segregation on the Test Bar," Mr. Putnam says:

"It looks as if the chemist was bound to knock out the advocate of the physical test willy, nilly. For now comes segregation to falsify the report of the scale on the breaking strength of the test bar! Who knows whether or not there was abnormal porosity at the point of fracture, due to segregation of graphite, or of sulphur? And how shall we determine the question except by chemical analysis? It may be said that analysis of the irons before casting would enable us to make a mixture that would insure against segregation. It would help, no doubt, yet it could hardly be claimed as absolutely certain, and to make sure, what else can be done than to analyze borings taken from the point of fracture, and also from each end of the test bar separately, and compare results? For we must still continue to use the test bar, even if we employ analysis. Because analysis is simply a test taken in order to make strong castings, etc., but it does not test the strength of the casting. The purchaser of castings to stand specified tensile or transverse strain will not pass them on the strength of pre-cast analysis. He accepts or rejects on the verdict of the broken test bar. And segregation may, in more senses than one, play smash with the test bar. The fact of segregation is, of course, indisputable. Surplus of a metalloid will cause, as may be seen in the case of graphite or silicon, phenomena easily recognized by the veriest tyro in metallurgy.

Most foundrymen have at times seen the squeezed-out graphite so profuse on the surface of castings that it could be brushed off in considerable quantity. It has been generally held that all the carbon was combined with the iron while in the molten state; but a writer recently expressed grave doubt concerning this, his doubt having been prompted by the appearance in large quantity of graphite on the surface after cooling, and it would not be at all surprising if he were right. It might well be that iron could be saturated with carbon, beyond which it could hold no more in combination, and so the surplus would simply float in the liquid mass.

"Silicon in excess will become segregated, and it shows in sharp angles in white crystals. Most foundrymen have probably noticed this phenomenon at times. All segregation does not appear solely on the surface, however. It may take place anywhere in the body of the casting.

"There may be a question as to whether the fact of segregation is detrimental or not. If the section be supercharged with a metalloid, uniformly distributed, would it not be weaker than if the surplus were segregated to the center? I hardly think there is doubt that the segregation out of the casting is beneficial. But when this phenomenon occurs at all, the mixture should be corrected. For segregation is a natural effort of the iron to get rid of something that is harmful to it. Not that the thing itself is harmful; only the excess.

"I started out with what may be considered a whimsical suggestion of analyzing the test bar at the point of fracture and at two other points. But there may be times when such painstaking would be very serviceable. Thus, a certain per cent of carbon is best for a certain class of castings. Now, say this is just what the iron will hold without segregation. According to what chemists say of this phenomenon, analysis of borings taken from several points of the bar would help to determine the proper mixture; because if segregation take place the analyses would vary in results. A few such analyses would enable the founder to adjust his mixture so that the ordinary methods—

that is, the pre-cast analysis—would enable him to avoid all danger of harmful segregation. Of course there are inter-relations and affinities of the various elements that enter into the problem, but these the analyst is familiar with, or ought to be, and he will, of course, always consider them in his processes. The amount of segregation is said to depend somewhat upon the duration of the cooling period. This ought to be considered in the determination of the sectional area of the test bar, and, according to the writer's notion, it emphasizes the importance of making the test bar to accord with the class of castings produced."